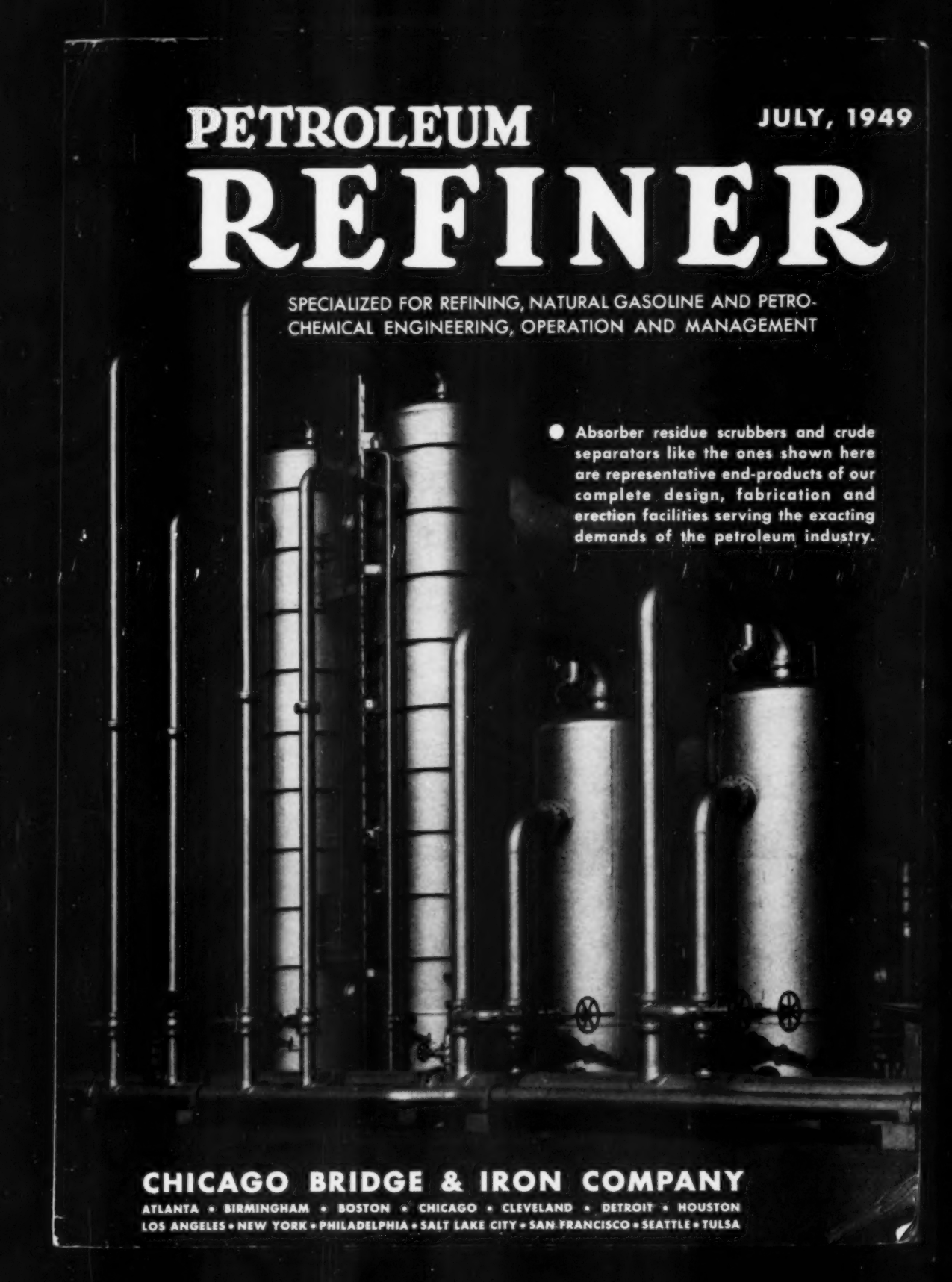
PETROLEUM REFINER

JULY, 1949

SPECIALIZED FOR REFINING, NATURAL GASOLINE AND PETRO-CHEMICAL ENGINEERING, OPERATION AND MANAGEMENT



● Absorber residue scrubbers and crude separators like the ones shown here are representative end-products of our complete design, fabrication and erection facilities serving the exacting demands of the petroleum industry.

CHICAGO BRIDGE & IRON COMPANY

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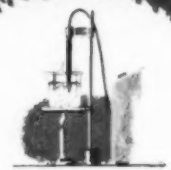
LOS ANGELES • NEW YORK • PHILADELPHIA • SALT LAKE CITY • SAN FRANCISCO • SEATTLE • TULSA

VIRTUALLY UNBREAKABLE!

So strong that the pH-sensitive bulb can withstand as much pressure as the thick stem itself!

Abrasion resistant — unusually rugged for long life and reliable measurement even in highly abrasive slurries!

Chemical durability — excellent in the strongest acids and alkalis . . . even at elevated temperatures!



COVER EXTREME TEMPERATURES!

30° to 130° C at high pH — with the new high temperature—high pH glass.

—20° to 100° C — with the new general-purpose glass. Will withstand even repeated freezing.

Now- NEW BECKMAN pH Electrodes

UNPRECEDENTED pH RANGE!

0 to 14 pH — with the high-temperature high-pH glass . . . *only small reproducible deviation near extreme limits, even at high temperatures.*

0 to 11 pH — at room temperature and 0 to 10 pH at boiling for the general-purpose glass . . . *without correction for sodium ions!*

IMPROVED CONSTRUCTION!

Simplified, heat-resistant construction eliminates wax filling . . . retains patented Beckman internal shielding . . . increases measurement precision.

Only *Beckman Glass Electrodes* offer all of these features:

▶ **RAPID RESPONSE** . . . accuracy with speed and convenience.

▶ **STABILITY** . . . to match the high precision of BECKMAN pH METERS.

▶ **INTERNAL SHIELDING** . . . gives complete freedom from outside electrostatic interference.

▶ **INTEGRAL LEADS** . . . Continuous insulation into the electrode . . . connections located on protected panel board.

▶ **EXTREME TEMPERATURE RANGE** . . . Several types permit use from below freezing to boiling *and above!*

▶ **ENTIRE pH SCALE** . . . *Very small* sodium ion errors . . . e.g., with high-temperature high-pH glass, only 0.2 pH deviation at 13.7 pH in 1 N sodium hydroxide.

▶ **FACTORY SEALED** . . . rigidly tested . . . no maintenance.

▶ **UNIQUE CHEMICAL DURABILITY** . . . in alkali . . . in acid . . . in dilute solutions.

And . . . *REALLY TOUGH* . . . can even be used as a stirring rod!

These new electrode glasses are now being used in several Beckman electrode styles. As rapidly as possible, they will be available in the full line of Beckman Glass Electrodes.

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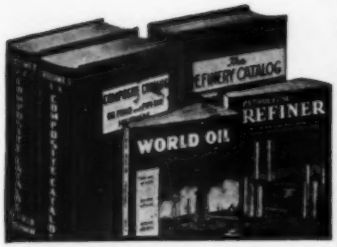

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THE GULF PUBLISHING COMPANY
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PETROLEUM REFINER and The REFINERY CATALOG
for the refining-natural gasoline industry

WORLD OIL (formerly The Oil Weekly)
and The COMPOSITE CATALOG
for the drilling-producing-pipe line industry

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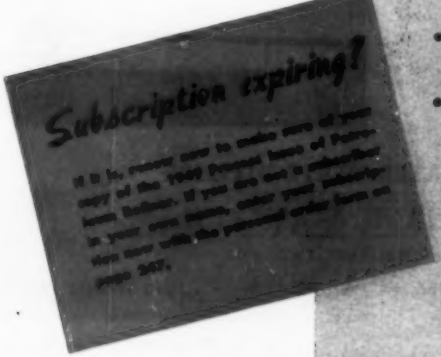
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PETROLEUM
REFINER

Specialized for Refining, Natural Gasoline and Petrochemical Engineering, Operation and Management

R. L. DUDLEY, President, Publisher A. L. BURNS, General Manager

VOLUME 28, NO. 7 July, 1949

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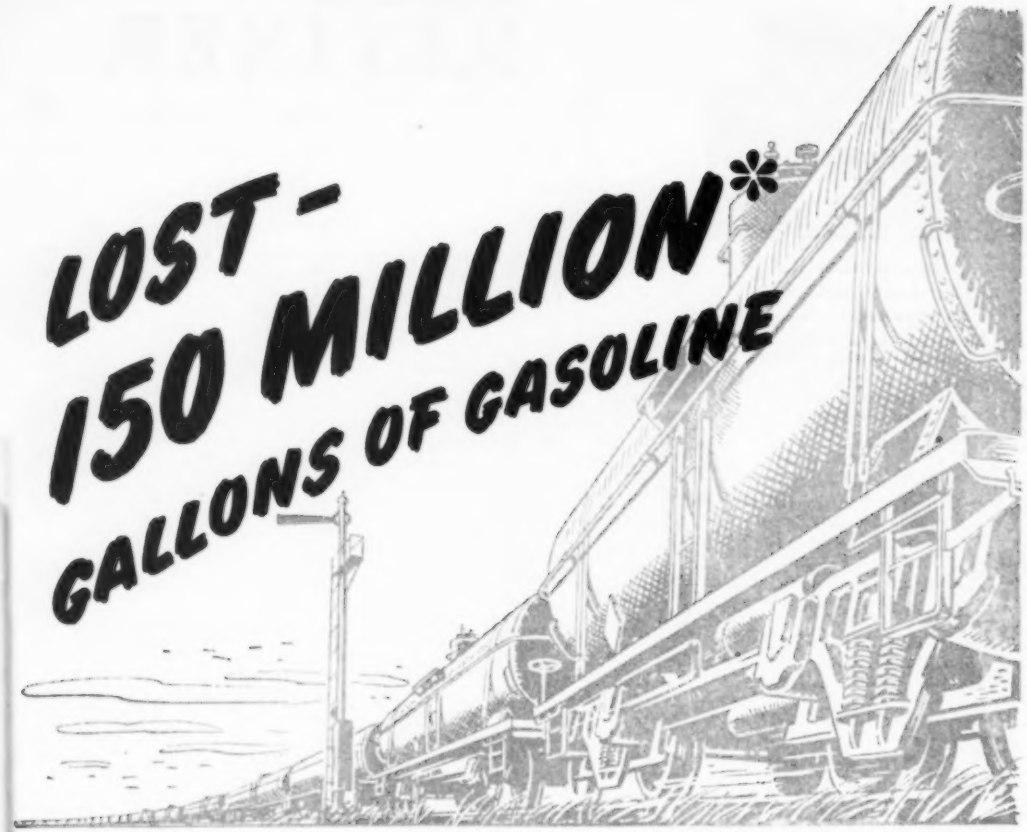
LOST - 150 MILLION* GALLONS OF GASOLINE



ENOUGH gasoline is lost by evaporation each year in this country to fill a tank car train 150 miles long. Much of this waste could be avoided through the use of Graver conservation equipment.

First and foremost in the battle for conservation is the Graver Expansion Roof Tank. It *ends evaporation losses* . . . provides protection of multiple tank installations through manifolding . . . maintains quality throughout the storage period. It also adds the advantages of *safety* — reduced fire hazard . . . *simplicity* — no maintenance problem . . . and *permanence* — no parts to wear.

With every one, from Congress to consumer, worried over dwindling oil reserves and so much gasoline vanishing into thin air, it's time to talk it over with Graver. Ask Graver engineers to analyze your storage problems and show you how the Expansion Roof stops vapor losses.

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FABRICATED PLATE DIVISION

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Mighty Mites

in Refinery Service

Those little traps with the big thirst—Yarway Impulse Steam Traps—are doing a giant's job in hundreds of refineries throughout the country.

Yarways are ideally suited not only for refinery work, but for all industrial trapping service. They literally *drink* the condensate—discharging *continuously* on heavy loads, *intermittently* on light loads. Hence they provide maximum heat in the shortest possible time to keep equipment at top efficiency.

Yarways are suitable for all pressures without change of valve or seat. Compact design makes them easy to install, and simplicity of construction (only one moving part) minimizes maintenance.

Next time old-type traps need repair, consider replacing them with Yarway Impulse Traps. New Yarways frequently cost less than the repair job. ***Over 600,000 have been bought!***

See your nearest Supply House, or write for Bulletin T-1739.

YARNALL-WARING COMPANY
128 Mermaid Ave., Philadelphia 18, Pa.

YARWAY IMPULSE STEAM TRAP

How to beat the heat . . . and get the best LIFE/COST ratio for your tubes

MANY high temperature steels will solve your heat, pressure, corrosion, and oxidation problems, but only one will give you the best life/cost ratio. That's why the Timken® Company has developed these twelve high temperature steels. No matter what your operating conditions may be, *one* of these fine steels is the right one to give you the service life you need at the *lowest possible cost.*

But which one of the twelve will give you maximum service-life and best economy? Through careful analysis of your particular requirements, Timken metallurgists can help you select the one steel which will give you the best life/cost ratio. With 20 years of research in high temperature tube applications behind them, these men are recognized authorities in the field.

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To get the best life/cost ratio from your tubes, call on the Timken Technical Staff now. Further information on Timken high temperature tubing may be obtained by writing to The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

TIMKEN 18-8 STEEL TUBING Shows the best combination of creep strength, oil corrosion resistance and oxidation

TIMKEN SICROMO 9 M STEEL TUBING This steel possesses the maximum corrosion resistance of any of the

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TIMKEN 4-6% CR MO STEEL TUBING For service up to 1200°F. Superior corrosion resistance. Less oxidation resistance

TIMKEN SICROMO 3 STEEL TUBING For service up to 1200°F. Has excellent oxidation resistance and good corrosion

TIMKEN 2¼% CR-1.0% MO STEEL TUBING For service up to 1150°F. Has greater resistance to creep than 2% Cr.

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TIMKEN DM STEEL TUBING For service up to 1150°F. This steel offers outstanding creep strength.

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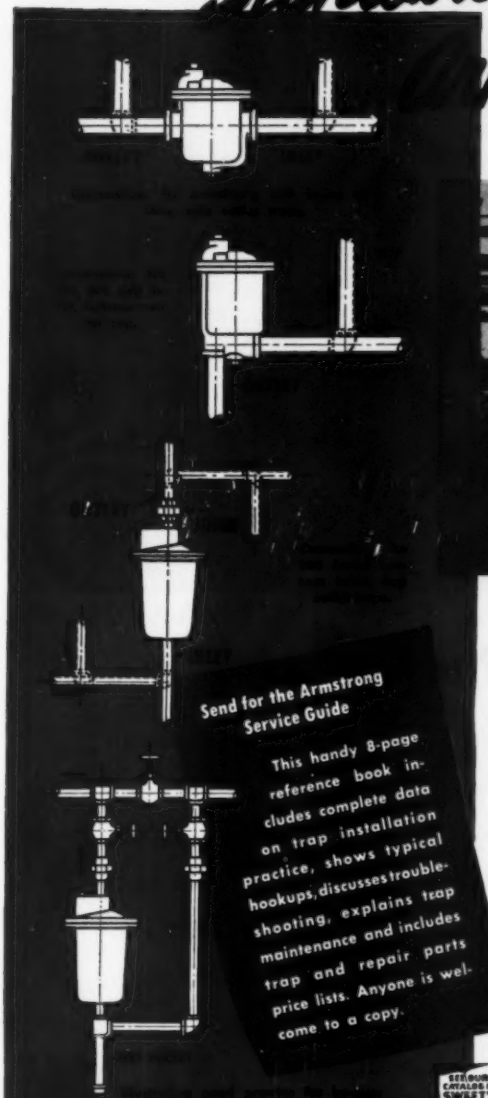
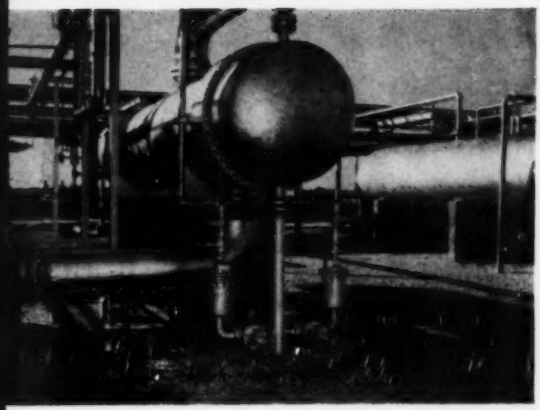
TIMKEN CARBON STEEL TUBING Generally for service not exceeding 900°F., where corrosion and oxidation resistance are not important.

50th birthday of the company whose products you know by the trade-mark TIMKEN

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing.

To Reduce Steam Trap Installati Costs *Standardize with Armstrongs*





Send for the Armstrong Service Guide

This handy 8-page reference book includes complete data on trap installation practice, shows typical hookups, discusses trouble-shooting, explains trap maintenance and includes trap and repair parts price lists. Anyone is welcome to a copy.

Small Size, Choice of Body Styles Save Time, Labor and Fittings

ARMSTRONG traps are compact, light and small in relation to capacity because the free-floating lever system permits full opening of a larger discharge orifice than is possible in other traps of comparable size. This makes them ideal for all installations, including those where space is limited. Even the largest size Armstrong traps rarely require any support other than the piping to which they are connected.

The choice of side inlet or bottom inlet body styles in sizes for the majority of installations permits the simplest possible hookups with a minimum of fittings.

For complete information on Armstrong Inverted Bucket Steam Traps for all services and all pressures call your nearest Armstrong representative or write direct to the factory.

SEE OUR CATALOG IN SWEET'S

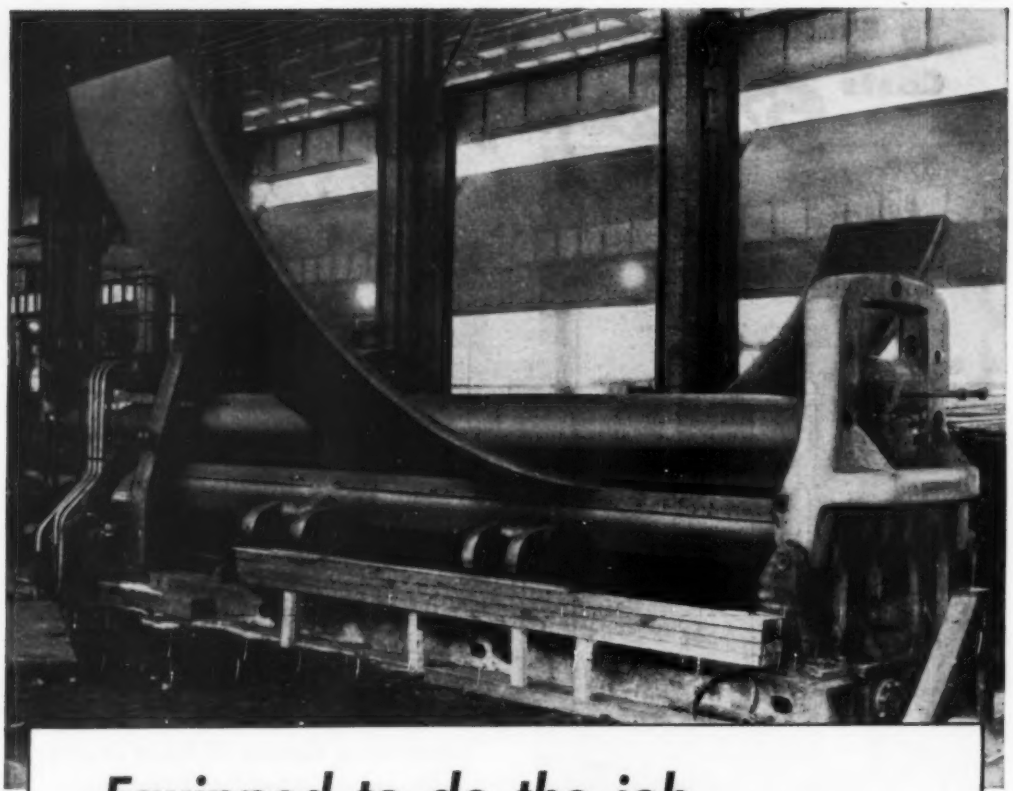
ARMSTRONG MACHINE WORKS

852 Maple St., Three Rivers, Mich.

ARMSTRONG INVERTED BUCKET STEAM TRAP

ARMSTRONG *Inverted Bucket* STEAM TRAPS

48 Key Cities . . . Traps Stocked at 147 Points



Equipped to do the job

Sun builds made-to-order units for all refinery and chemical plant processes. Sun also furnishes repair services and parts. This is evidence of the vastness of Sun facilities, facilities that include rolls so powerful as to be capable of cold bending steel sheets 3½" thick . . . Having similarly extensive facilities for shipbuilding, Sun turns out record-making tankers and cargo vessels from keel to superstructure—no subletting.

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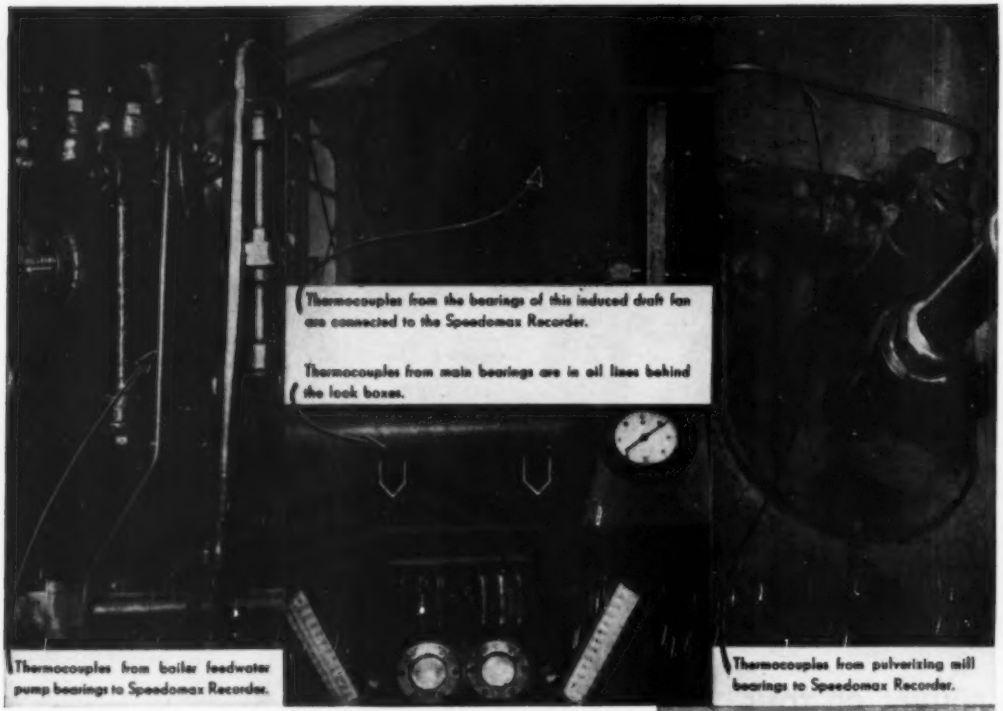
Thermocouples from the bearings of this induced draft fan are connected to the Speedomax Recorder.
Thermocouples from main bearings are in all lines behind the look boxes.
Thermocouples from boiler feedwater pump bearings to Speedomax Recorder.
Thermocouples from pulverizing mill bearings to Speedomax Recorder.

Temperature from These 4 Points
. . . and 156 more . . .
At ONE Speedomax Recorder

Remarkably fast, this new Speedomax offers a definite advance in temperature checking and recording. With Speedomax, an operator can "tour" the temperatures of 160 points in a little less than eleven minutes. He can watch readings as they are automatically indicated; or Speedomax will record them for later examination and for the shift log.

Readings are supplied in such rapid rotation, that it is generally possible to spot any high or low temperature as soon as it develops. In addition, greater operating efficiency is obtained because of the centralization of instrument readings.

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For further information about this versatile temperature checking equipment, simply write for your copy of Folder ND46-33A(1). Address Leeds & Northrup Company, 4923 Stenton Avenue, Philadelphia 44, Penna.

Speedomax Recorder for all points shown and enough more to record a total of 160.

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Jrl. Ad. ND46-33A(2)

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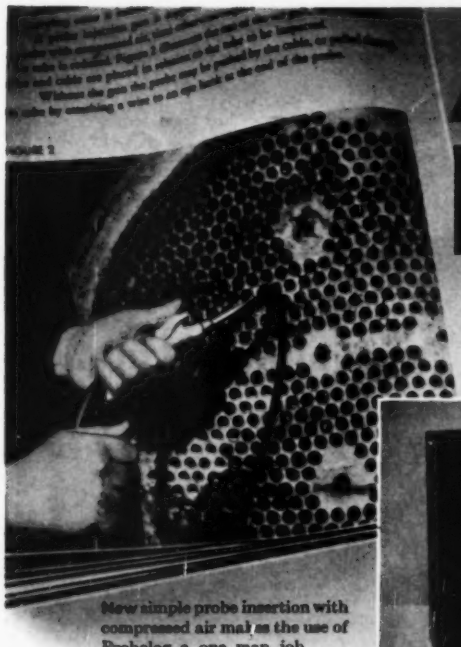
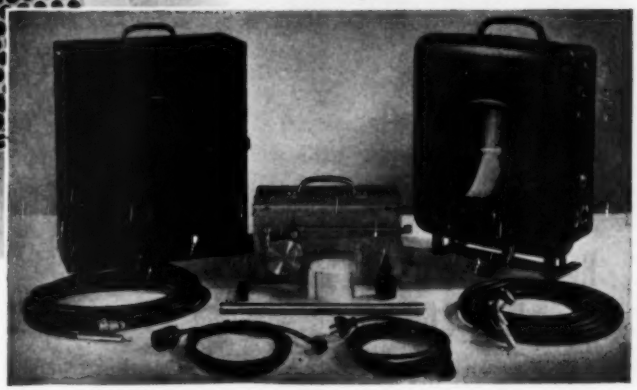


Now simple probe insertion with compressed air makes the use of Probolog a one man job . . . greatly speeds up tube checks.



Improved– HIGHER PROBE SPEED

Improved– MULTI-PURPOSE PROBES

Improved– SIMPLE, PRECISE CONTROL SETTINGS

Probolog is the much-discussed electronic instrument which makes visible, permanent records of the condition of individual, non-magnetic tubes in heat exchangers and other tubular equipment.

After several years of commercial service, Probolog has earned a unique record of reduced maintenance costs, of unfailing accuracy and safety in the inspection of tubular equipment.

Shell has now added several improvements to the original Probolog, making it even more precise, more versatile and easier to use.

A new booklet contains a comprehensive description of Probolog and its operation. Please use the coupon. Demonstration can be arranged.

Shell Development Company, Incorporated
50 West 50th Street, New York 20, New York

Please send me a copy of "The Probolog."

Name_____ Title_____

Company_____

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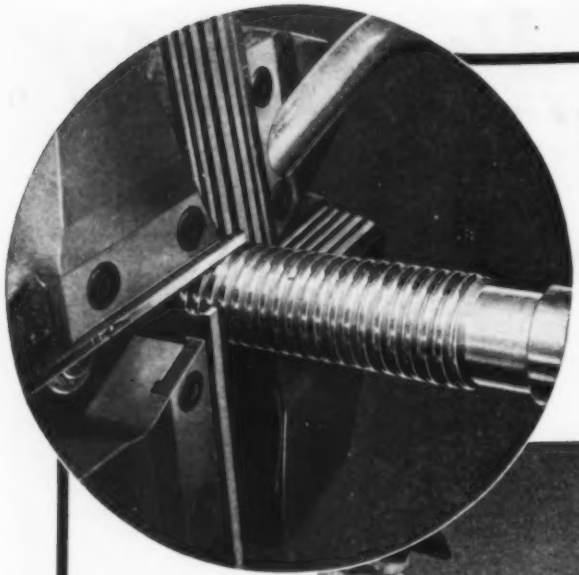
City_____ State_____

SHELL



94.2% SAVING IN Threading Time

Right- and left-hand Threads in 4.66 min.

• 79.74 minutes formerly were required to cut threads on both ends of vise screws. The 1⅝" 4 pitch Acme threads 5¼" long on each end are now cut in one pass in 4.66 minutes floor-to-floor time, using a Landmaco Threading Machine equipped with Lead-screw Attachment.

In finishing 12.9 pieces per hour, the machine is operated at a cutting speed of 24 surface feet per minute at 57 R.P.M. This large eastern manufacturer states that "production is increased 1710% over best methods previously used."

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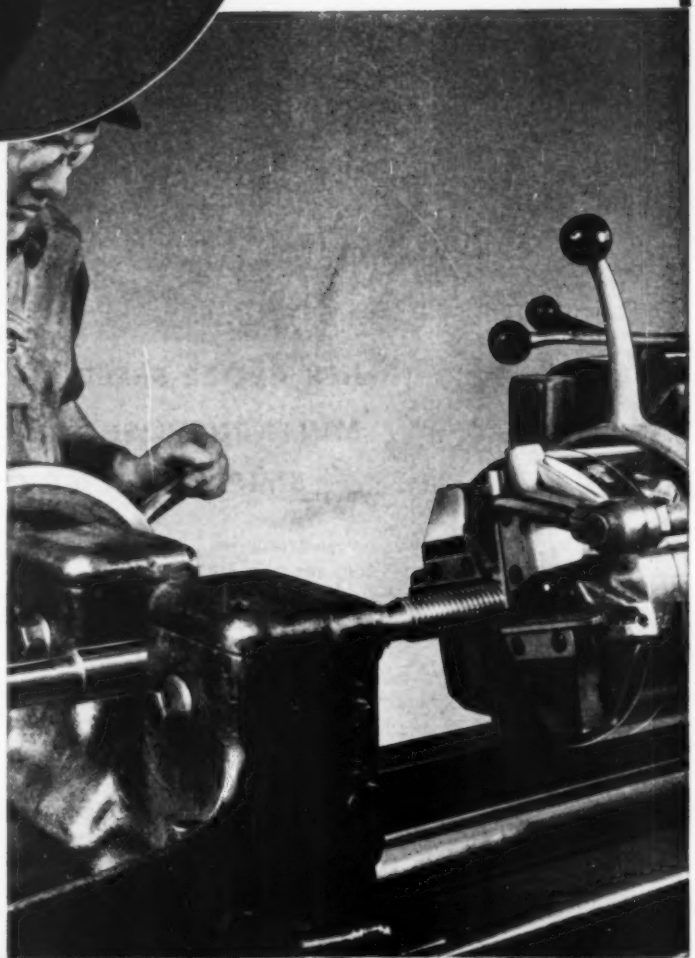
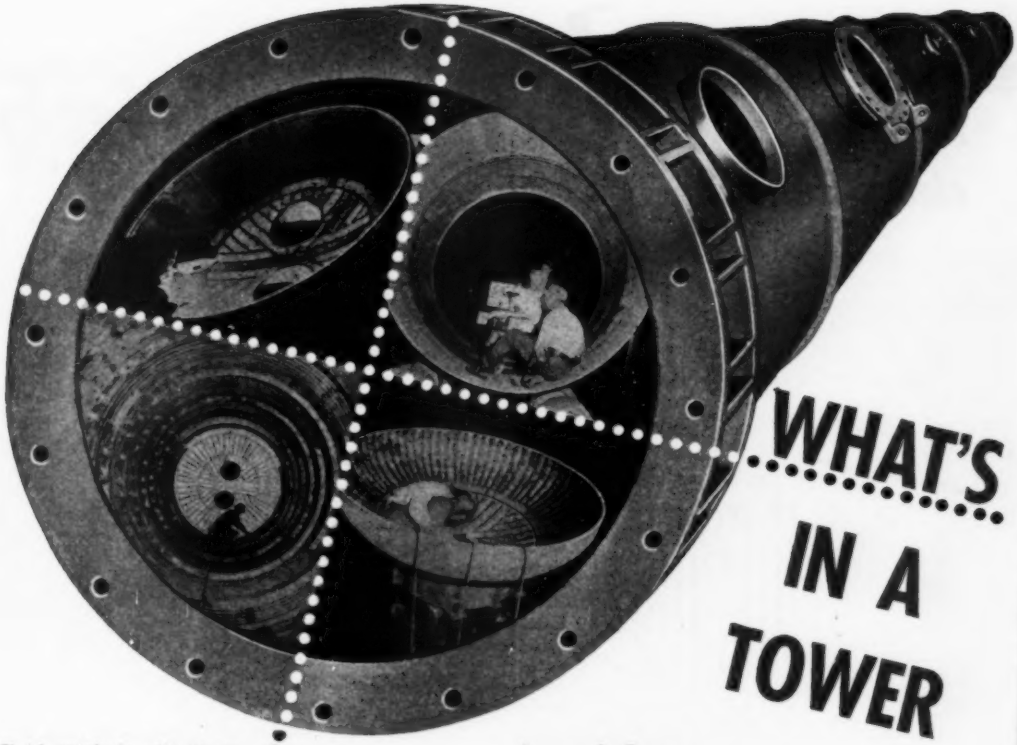
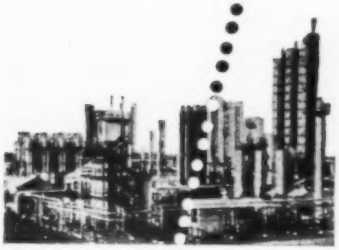


THREADING MACHINERY—THREAD CUTTING DIE HEADS—COLLAPSIBLE TAPS



...WHAT'S IN A TOWER

Fluid catalytic unit tower 8'0" ID x 50'0" 3/8" steel shell, clad with 12 gauge stainless steel strips, complete with tray supports...Nooter fabricated to Universal Oil Products Co. design.



besides design and metal?

Well, for one thing: Over one mile of Nooter *DuraPure* Welding. The continuous automatic and manual arc-welded construction surpasses API-ASME Code specifications. . . Uniform bond achieves high strength, and surface purity of welds maintains corrosion-resistance. Stress-relieving insures safety and precise, undistorted alignment.

After being cross-checked for precision fit-up the vessel was shipped on schedule — ready for erection.

This is why Nooter-fabricated equipment is competently serving the petroleum industry throughout the world.

When your blue prints are ready — call in Nooter!

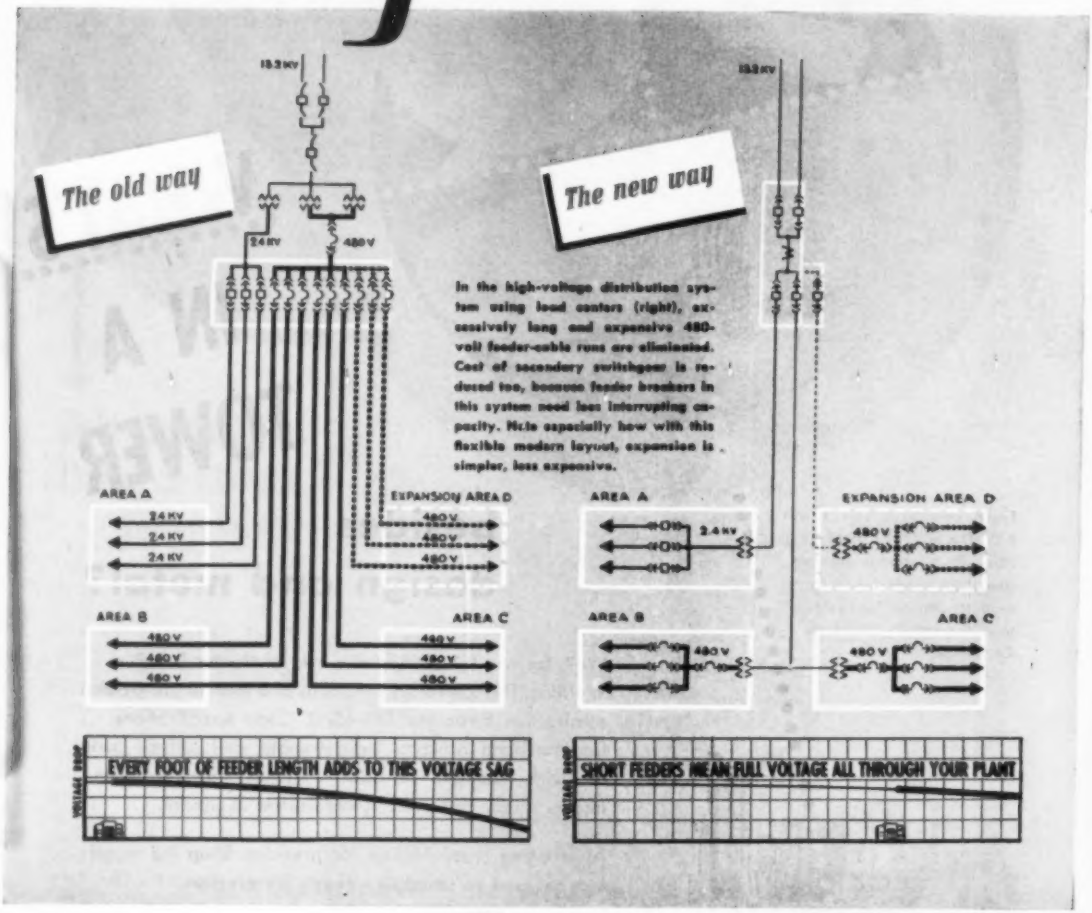
NOOTER

Nooter Catalog, complete with corrosion data charts is sent at your request.

JOHN NOOTER BOILER WORKS CO. • 1404 South Second St. • St. Louis 4, Mo.

What's the trend in refinery electrification?

more high-


The old way
The new way
13.2 KV
2.4 KV
480 V
In the high-voltage distribution system using load centers (right), excessively long and expensive 480-volt feeder-cable runs are eliminated. Cost of secondary switchgear is reduced too, because feeder breakers in this system need less interrupting capacity. Note especially how with this flexible modern layout, expansion is simpler, less expensive.
AREA A
EXPANSION AREA D
AREA B
AREA C
EVERY FOOT OF FEEDER LENGTH ADDS TO THIS VOLTAGE SAG
SHORT FEEDERS MEAN FULL VOLTAGE ALL THROUGH YOUR PLANT

Here's what you need to modernize your power system!

WHEN YOU COME TO GENERAL ELECTRIC you get far more than the finest in electrical equipment. A General Electric application engineer, familiar with refinery practices, is at your disposal. If desired, he stands ready to take over the job of co-ordinating all the needed components, engineering your power distribution into one modern, efficient system.

voltage distribution

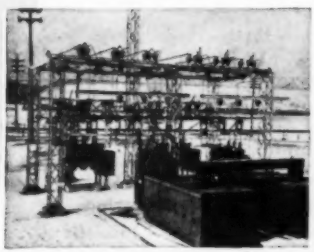
to reduce power losses, cut equipment costs

You see it in more and more refineries today. It's the trend to load-center power distribution. High voltage power is distributed within the plant right to the heart of electrical load areas. There it's stepped down to utilization levels in load-center unit substations and carried to points of use by *short* low-voltage secondary feeders.

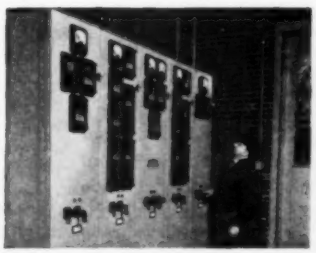
This modern method provides several advantages. By replacing long, low-voltage feeders with short ones, voltage fluctuation is kept within narrow limits, and voltage drop is lessened. This cuts power losses, permits plant equipment to run at full efficiency.

Economies in the cost of cable runs, as well as in the cost of transformers and secondary switchgear, go hand in hand with high-voltage distribution. Plant rearrangements or additions can be made at less cost because of the flexibility of this system. Lower maintenance costs and easier installation are added advantages.

THREE KINDS OF HELP . . . NO OBLIGATION! It's a simple matter for you to get the whole story on how modern refinery power distribution can affect your plant layout, operating continuity, costs. As a service to industry, General Electric offers a 3-point program comprising (1) A fact-filled manual, without sales talk, on plant power distribution; (2) A slidefilm with sound that shows in detail what load-center distribution is and what it does; (3) Illustrated booklets highlighting the main points of manual and film. Write today to have this helpful program made available to you and your staff—without charge or obligation. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*



These completely metal-enclosed G-E package substations are factory-built to fully co-ordinated designs. You save both engineering time and installation time.

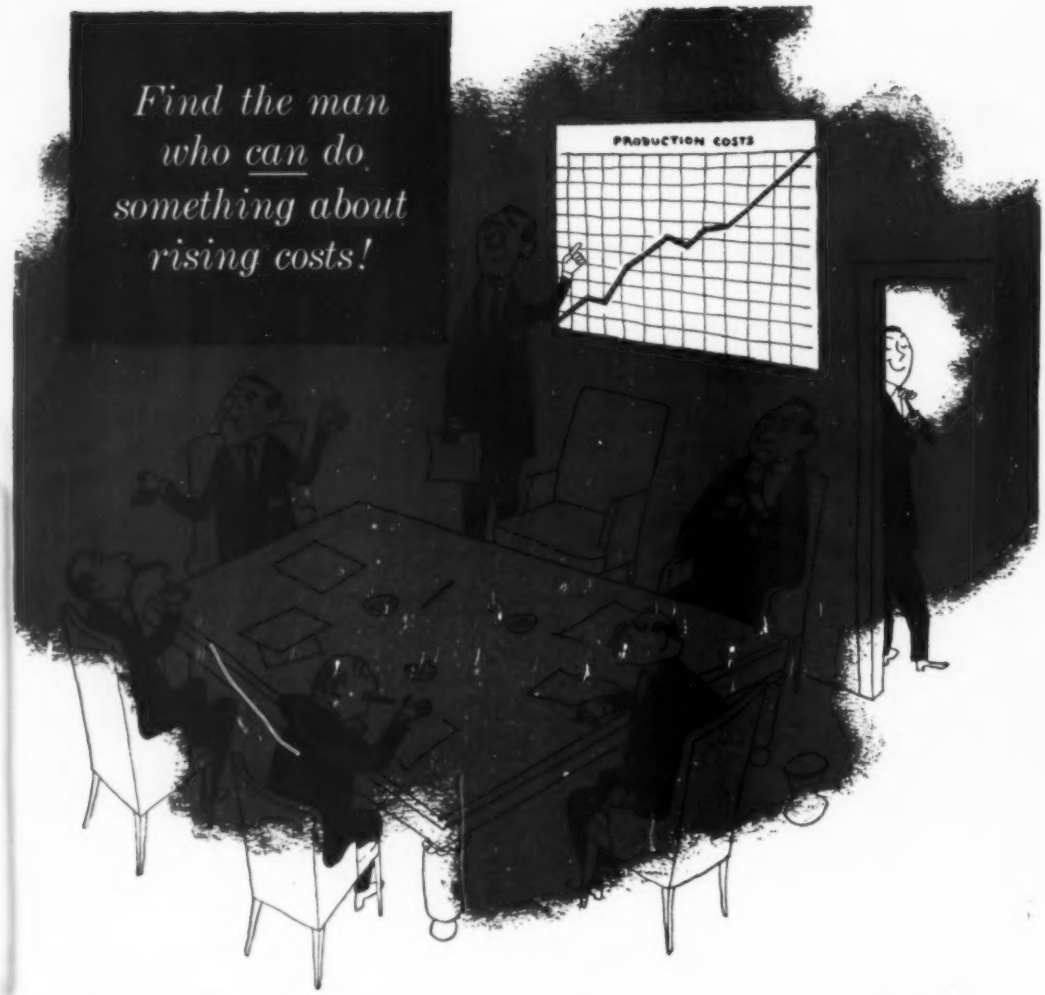


In G-E metal-clad switchgear, convenient vertical-lift construction of magne-blast air circuit breakers makes it a quick, easy job to remove them for inspection or maintenance.

Load-center unit substations—compact, fully enclosed, and built from matched components—are complete, easy-to-specify units. Made in flexible combinations, easy to rearrange.

GENERAL ELECTRIC 661-8

Find the man who can do something about rising costs!



In most businesses, operating costs are still on the rise. But there's *one* man who *can* do something about it—he's the man whose job is to get maximum heat and power from fuel dollars. He knows you *get* maximum efficiency from Eagle-Picher Industrial Insulations because they're made of durable, chemically and physically stable *mineral wool*, noted for its low conductivity. They give long years of service and are easy to maintain and replace.

There's an Eagle-Picher insulation that can help reduce *your* operating expenses!

Let these Eagle-Picher products also save you money . . . power . . . time

Insulating Felts
Supertemp Block • Blankets
Loose Wool • Pipe Covering
Stalastic • Insulseal • Insulstic
Swetchek • Finishing Cements
Insulating Cements

THE EAGLE-PICHER COMPANY

General Offices: Cincinnati (1), Ohio

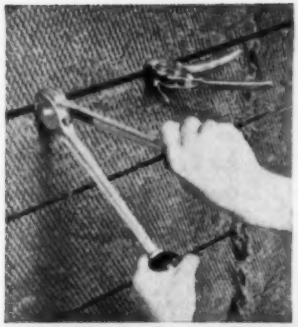
Insulation products of efficient mineral wool—for a full range of high and low temperatures. Technical data on request.

EAGLE EP PICHER *Since 1843*

The perfect answer

FOR MAXIMUM FUEL SAVINGS AND EXACT TEMPERATURE CONTROL

For a completely effective, low-cost insulation combination, you can't beat the teamwork of Eagle-Picher Mineral Wool Blankets, Supertemp Blocks, Super "66" Cement and Insulseal. They work effectively to give your equipment higher efficiency . . . cut operating costs . . . and help to provide perfect, precise control over temperatures.



EAGLE-PICHER MINERAL WOOL BLANKETS

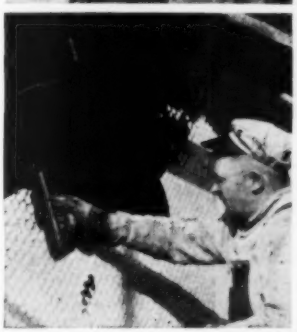
These blankets satisfy the need for a convenient method of quickly and efficiently insulating flat or curved surfaces on larger types of heated equipment. Mineral wool is felted and secured between flexible metal fabric. Outstanding physical and chemical stability enable Eagle-Picher Blankets to resist water, steam, corrosive fumes and normal vibration.

EAGLE-PICHER SUPERTEMP BLOCKS

Eagle-Picher Supertemp Blocks are lightweight (approximately 16 lbs. per cu. ft.). Can be cut easily with knife or saw to fit off-shaped areas . . . they fit snugly over minor irregularities. They're strong and have high refractory value. Withstand temperatures up to 1700 F. Conductivity at 512 F. approximately 0.43...all standard sizes, from 3" x 18" to 12" x 36" . . . in thicknesses from 1" to 4".

EAGLE-PICHER SUPER "66" INSULATING CEMENT

Super "66" is all-purpose, rust-inhibitive, extremely adhesive insulating cement. "Springy ball" pellets don't collapse after application . . . give great coverage, retain their thermal efficiency. 100 lbs. covers 65 sq. ft. —1 inch thick! Easily applied with trowel, over flat and irregular surfaces. Efficient for temperatures up to 1800 F. Reclaimable when used on equipment whose temperatures go up to 1200 F.!



EAGLE-PICHER INSULSEAL

A tough, weatherproof, protective coating for insulation. For temperatures up to 450 F. Applied as a plastic, its smooth troweling qualities assure uniform coverage, proper thickness. It protects insulation from air infiltration, fumes, rain, snow, vibration, punctures, and withstands severe service, indoors or out. Dries to a smooth, rich black, has a neat appearance on hot or cold surfaces . . . may be washed or painted.

THE EAGLE-PICHER COMPANY General Offices: Cincinnati (1), Ohio

Insulation products of efficient mineral wool—for a full range of high and low temperatures. Technical data on request.

EAGLE EP PICHER

Since 1843

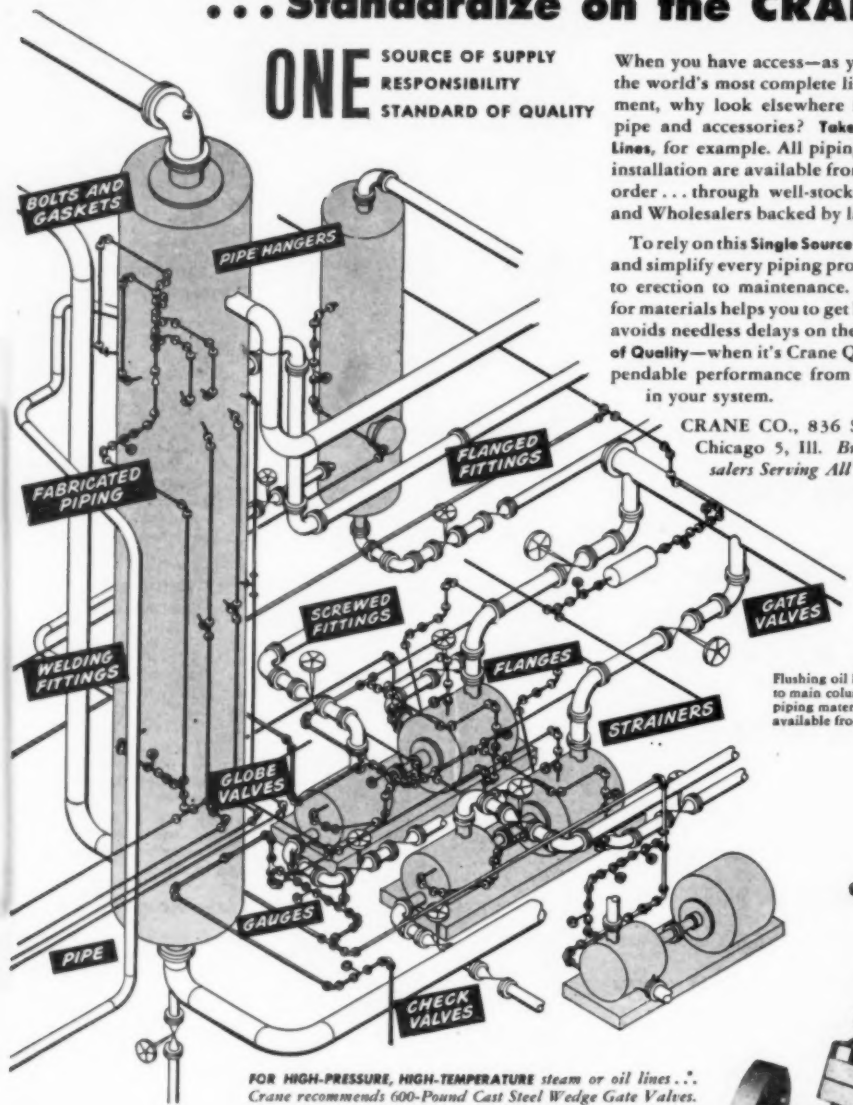
How to simplify piping jobs ... Standardize on the CRANE line

ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

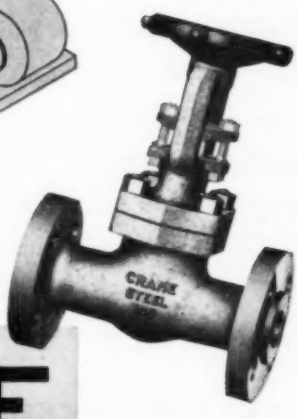
When you have access—as you do at Crane—to the world's most complete line of piping equipment, why look elsewhere for valves, fittings, pipe and accessories? **Take these Flushing Oil Lines,** for example. All piping materials for the installation are available from Crane . . . on one order . . . through well-stocked, local Branches and Wholesalers backed by large factory stocks.

To rely on this **Single Source of Supply** is to speed and simplify every piping procedure from design to erection to maintenance. **One Responsibility** for materials helps you to get better installations, avoids needless delays on the job. **One Standard of Quality**—when it's Crane Quality—assures dependable performance from every piping item in your system.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill. *Branches and Wholesalers Serving All Industrial Areas.*



Flushing oil lines to main column—all piping materials available from Crane.



FOR HIGH-PRESSURE, HIGH-TEMPERATURE *steam or oil lines . . . Crane recommends 600-Pound Cast Steel Wedge Gate Valves. Shown here, No. 3615X Gate with outside screw and yoke. Exelloy to Exelloy seating makes these valves ideal for oil and oil vapor services up to 1000 deg. F. Flanged, screwed, or socket-welding ends. Sizes: ½ to 2 in. See your Crane Catalog.*

EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM

teamwork

Two types of teamwork play important roles in the engineering and construction of a plant: (1) Internal — within the contractor's own organization, (2) External — between the contractor's and your personnel.

Internal teamwork shows up in records of successful accomplishment, a product of experience in working together on job after job. But the extent of external teamwork is more difficult to predict.

In carrying out its contracts, Lummus assumes a responsibility for giving you the benefit of all that your staff can contribute, as well as our own. We do not lean on your staff for ideas. But neither do we *lean away* from preferences they express or suggestions they offer. Your Lummus-built plant makes the most of the combined experience of your people and ours.

LUMMUS designs and builds with **TEAMWORK**

Economy
Fulfillment
Perspective
Resourcefulness
Technique

teamwork in process development

In the development of improved methods of producing lubricating oil, Lummus has worked in close-knit cooperation with many leading oil companies. Lummus' exclusive pilot plant equipment for lube-oil process development has been employed to explore process alternatives suggested by these customers, supplementing their own research. More than 85 process units for solvent refining and dewaxing have resulted from this work — including the largest lube-oil plant in the world.

teamwork in plant design

Lummus coordinated its engineering with the requirements and preferences of a leading chemical company — and laid the groundwork for an advanced type of ethylene plant. High yields are being obtained from a wide range of charge stocks. Operating costs are favorable, too.

teamwork in plant construction

Construction in foreign countries and remote locations calls for a close relationship at the site between Lummus' personnel and oil company field forces. Assignment of men with a thorough knowledge of the region, its customs, laws and labor regulations, helps maintain this local cooperation. Records are maintained in accordance with client requirements for progress reports and cost control.

THE LUMMUS COMPANY
420 Lexington Avenue, New York 17, N. Y.

LUMMUS

CHICAGO—600 South Michigan Avenue, Chicago 5, Ill.
HOUSTON—Mellie Esperson Bldg., Houston 2, Texas

The Lummus Company, Ltd., 525 Oxford St., London, W-1, England

Société Française des Techniques Lummus
39 Rue Cambon, Paris 1er, France

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Esquina Las Gradillas, Caracas, Venezuela

PLUGS ARE OUT WITH CHLORINATION

Costly plug cleaning, with its high labor bills and lengthy equipment down-time, goes out of the condenser and heat exchange picture the minute chlorination arrives.

This proven process for cutting the costly effects of back pressure and poor heat transfer characteristics caused by slime, really works, as one Southern Power Station found out when they began using the W&T De-sliming Process. In just six months after W&T Chlorinators were installed, cleaning and excess steam costs were reduced from $1450 per month to $250 per month and a later survey showed an overall saving in excess steam costs of $16000 in a year.

Such savings are indicative of how your condensers may be made to operate more economically and with far less outage when W&T Engineers install chlorination to fight your slime problems.

To learn how chlorination may be profitably applied to your heat exchange equipment and to take advantage of W&T's 35 years' experience, write today.

WALLACE & TIERNAN
PRODUCTS, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
Belleville 9, New Jersey • Represented in Principal Cities

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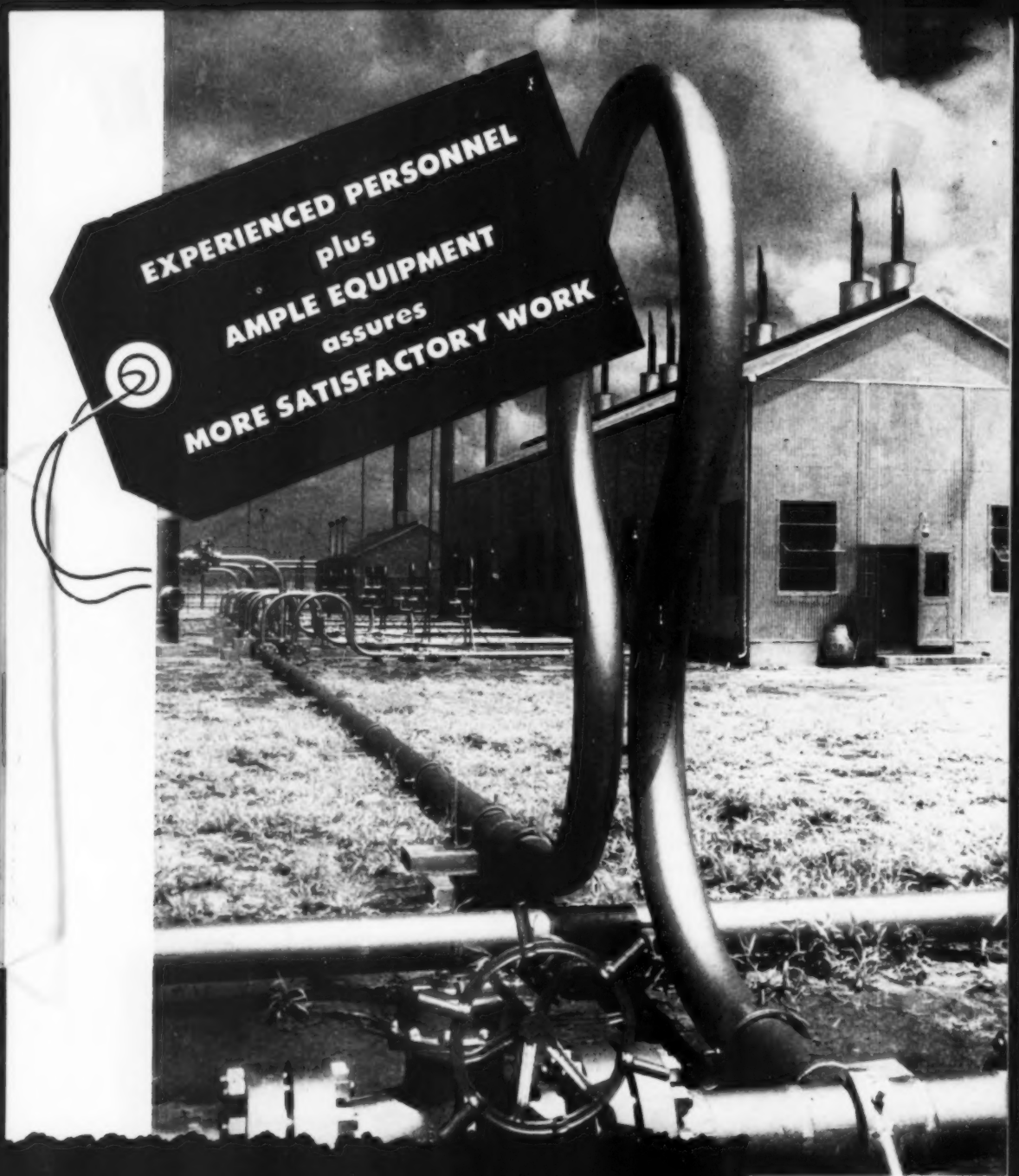

TEXAS PIPE BENDING COMPANY

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PIPE COILS
WELDED HEADERS

Pipe Fabricators
HOUSTON TEXAS

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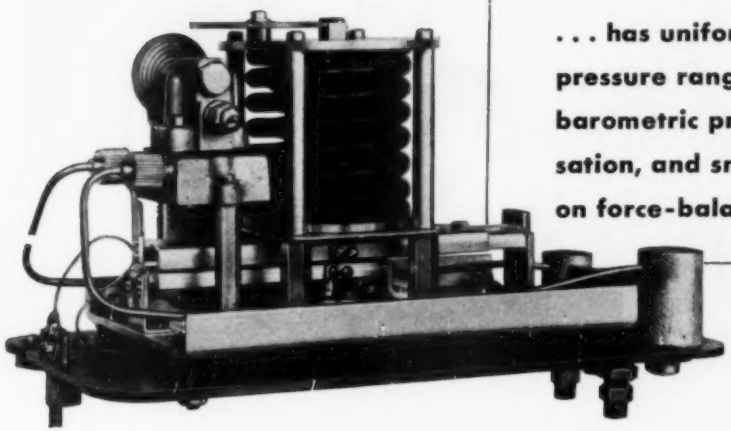
New Taylor Temperature Transmitter with SPEED-ACT

TRANSAIRE*



. . . has uniform output pressure range of 3 to 15 psi, barometric pressure compensation, and small bulb. Works on force-balance principle.

AT a meeting in Texas the other day, oil men praised this new Taylor TRANSAIRE force-balance temperature transmitter for three features above all others:

1. Standard output pressure range of 3 to 15 psi cuts maintenance, making special calibration of receivers unnecessary.

2. Barometric, temperature compensation, exclusive with Taylor, is vitally important where close temperature measurement and control are critical.

3. Cigarette-size bulb speeds up response; can be installed in limited space.

IN ADDITION, SPEED-ACT, employing for the first time derivative response to the measuring system, may be added to compensate for thermal lags where separable wells are required.

OTHER IMPORTANT ADVANTAGES FOLLOW:

Faster—63% response in less than 2 seconds.

Up-to-1000-feet pneumatic transmission of temperature with extreme accuracy.

Little or no maintenance needed, thanks to force-balance principle which practically eliminates wear.

Short, shiftable range spans with a simple screwdriver adjustment.

Great overrange protection. Overall temperature limits from minus 375° to 1000°F.—with overrange protection to 1000°F.

No electrical hazard in explosive atmospheres.

A positive-acting pilot valve assures quick changes in transmission pressure, overcomes effect of minor leaks.

TRANSAIRE with Speed-Act is the latest step in Taylor's program to produce industrial instrumentation unsurpassed in *accuracy* and *durability*. Ask your Taylor Field Engineer or write for **Bulletin 98140.** Taylor Instrument Companies, Rochester, N.Y., or Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.*

* Registered Trade-Mark

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

With that pile of paraphernalia up front, no wonder the Indian guide is grumpy. He has no steam power plant to propel that mess of mail order equipment. Oh, how he'd love to give it the water treatment . . . a dunk in the drink would solve *his* problem! • But it takes another kind of water treatment—another kind of HOW—to squelch corrosion, scale and carryover in a power plant. It takes a time-proved, scientifically developed treatment system to reduce down-time for cleaning, repairing and replacement and to maintain high operating efficiencies. • Bird-Archer has been successfully solving water treatment problems for more than a half century. Get the full benefit of this experience by discussing your water treatment problems . . . whether for power, process or cooling . . . with a Bird-Archer Field Engineer.

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NEW BULLETIN

CORROSION PROTECTION OF STEAM CONDENSATE RETURN SYSTEMS

Just off the press, this informative bulletin outlines the Bird-Archer method of amine treatment. Write for your free copy today.

PEERLESS VERTICAL TURBINE PUMPS

CUT OVERHEAD Underground

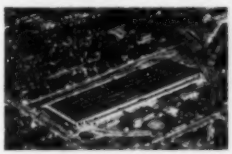
For your next job consider the flexibility and the efficiency of the Peerless vertical turbine pump.

As a deep well pump, for example, a Peerless pump can assure you of an independent source of clean water from your own well—water that will be of constant temperature, of constant chemical analysis. To cut overhead underground, Peerless turbine pumps embody many exclusive engineering advantages, such as patented Double Bearing-Double Seal bowl construction, all contributing to their extended trouble-free pumping life.

As another example, a Peerless vertical turbine pump utilized as a close-coupled pump, assures you of full turbine pump utility and capacity from short or medium settings. They're ideally suited for installation over pits, sumps or basins or for pumping water from surface sources. The 4 pumps shown above are indicative of this type of service. You can easily visualize their application to condenser cooling, cooling tower service, etc.

Regardless of your requirements, a versatile Peerless vertical turbine pump will squarely meet your pumping demands. Peerless offers widest capacity range, from 15 to 30,000 gpm against heads to 1000 feet. You can have your choice of oil lubricated or water lubricated types and a choice of power drive, direct-connected electric, right angle gear, V or flat belt or combination drives. Write for individual Bulletins describing the applications of Peerless pumps to these services.

NEW PEERLESS INDIANAPOLIS PLANT IS DEVOTED ENTIRELY TO PUMP PRODUCTION AND SERVICE



Here is one of America's newest pump plants—19 acres of modern manufacturing facilities devoted to precision production of horizontal and vertical pumps, centrally located at Indianapolis. Plan with Peerless for pumps plus fast, complete pump service.

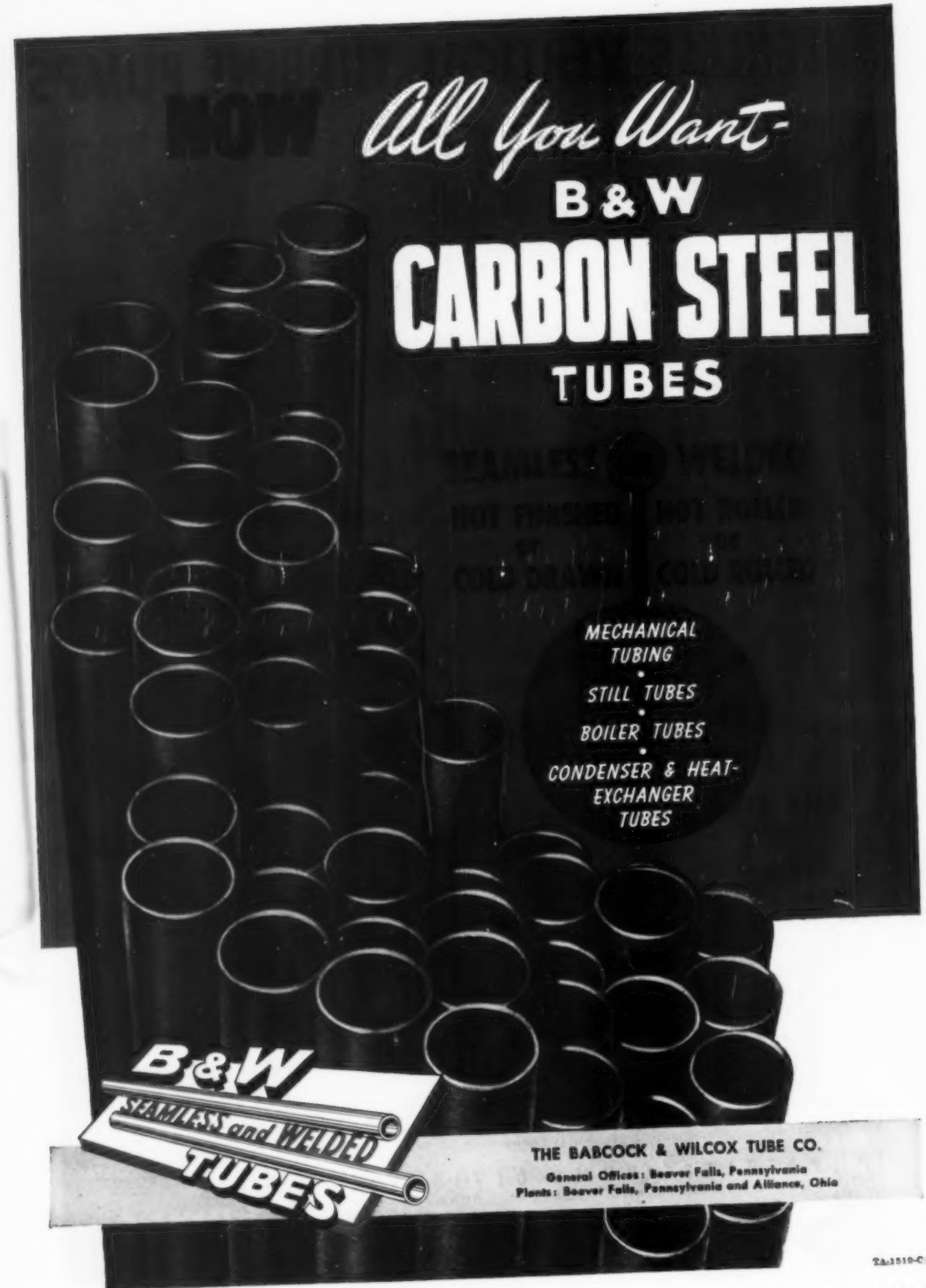
Peerless
VERTICAL AND HORIZONTAL
Pumps

fmc
PEERLESS PUMP

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION

Los Angeles 31, California — Indianapolis, Indiana

District Offices: New York 5, 37 Wall Street; Chicago 40, 4554 N. Broadway; *Atlanta Office:* Rutland Building, Decatur, Georgia; Omaha, Nebraska, 4330 Leavenworth Street; Dallas 1, Texas; Fresno, California; Los Angeles 31, Calif.


Now All You Want-
B&W
CARBON STEEL
TUBES
MECHANICAL TUBING
STILL TUBES
BOILER TUBES
CONDENSER & HEAT-EXCHANGER TUBES
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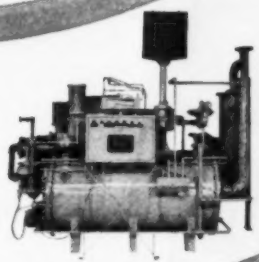
SEAMLESS and WELDED
TUBES
THE BABCOCK & WILCOX TUBE CO.
General Offices: Beaver Falls, Pennsylvania
Plants: Beaver Falls, Pennsylvania and Alliance, Ohio
TA-3510-C1

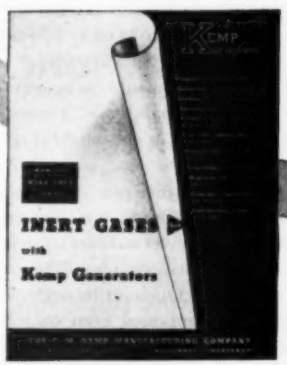
INERTS . . . 24 HOURS A DAY

Whatever your needs . . . purging, flushing, blanketing, agitating, controlling . . . you can make your own inert gases in your own plant 24 hours a day.

- And the cost to you, compared with all that goes with outside bottled gas cylinder handling, is *really low*—from 10¢ per Mcf for unprocessed inerts up to 18¢ per Mcf for compressed nitrogen.
- Cheaply and conveniently, you can produce inert gases 24 hours a day, if your processing demands it, with Kemp Inert-Gas generating systems . . . completely automatic, permanent, and virtually free of maintenance for years of dependable service.
- You can learn more about Kemp Inert-Gas Producers by talking to our representative...or write for the NEW Bulletin No. I-10 for the story.

Model 5 MIHE
Capacity 5000 CFH Inert gas at 15 inch water column discharge pressure. →





The C. M. Kemp Manufacturing Co.
405 East Oliver Street, Baltimore 2, Maryland

☐ Please send a Kemp representative in to see me.
☐ Please send me your NEW Bulletin No. I-10 on Inert Gases.

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Street .....
City ..... Zone ..... State .....

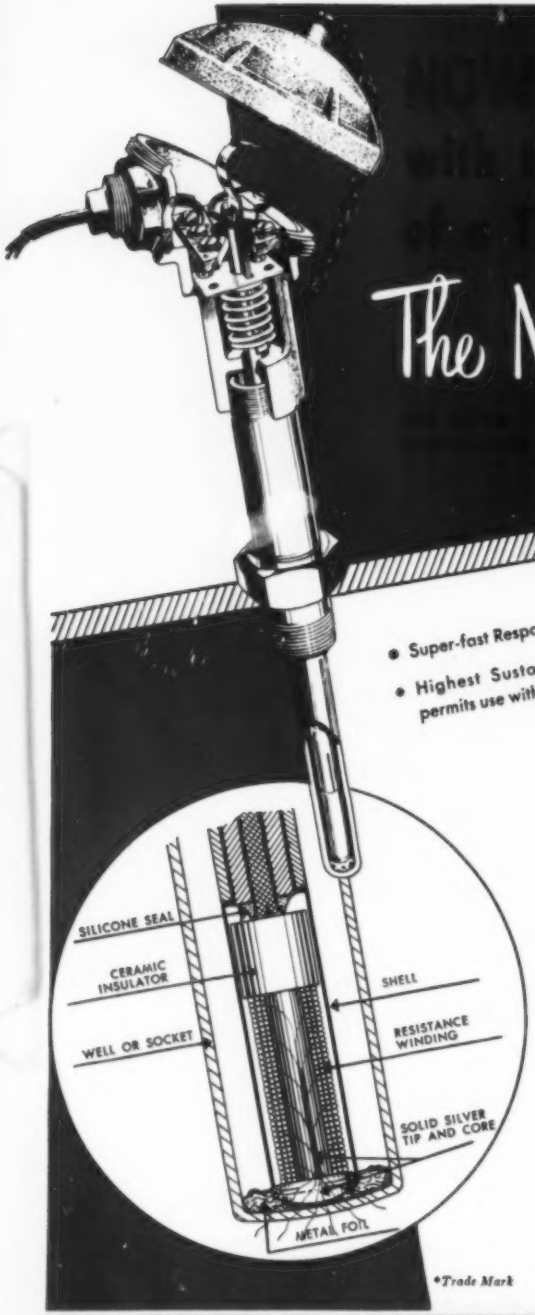
MPH-7

KEMP of BALTIMORE

PRECISION CARBURETORS • BURNERS FOR INDUSTRIAL HEAT CONTROL • FIRE-CHECKS AND OTHER SAFETY DEVICES

ATMOSPHERE GENERATORS • INERT GAS PRODUCERS • ADSORPTIVE DRYER SYSTEMS FOR PROCESS CONTROL

The New Dynatherm*



- Super-fast Response.
- Highest Sustained Accuracy . . . permits use with very narrow scales.
- Positive Metal-to-Metal End-Contact with Well or Socket.
- Fits Any Well or Socket ¼" Inside Diameter or Larger.

The new Dynatherm Resistance Bulb, with its super-fast end-contact, combines the advantages of both thermocouple and resistance type temperature measurement in ranges up to 600°F.

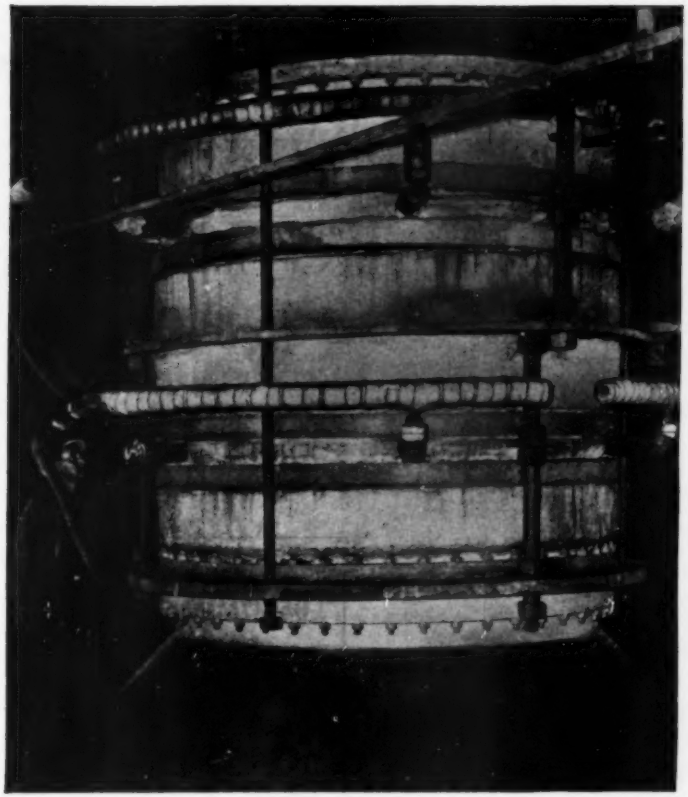
For the first time, it is now possible to benefit from the inherent accuracy and stability of a resistance bulb, without premium cost or the need for special wells or sockets.

The Dynatherm offers higher sustained accuracy than thermocouples. It eliminates need for cold junction compensation . . . gives stability in measurement impossible with thermocouples. This resistance bulb is so sensitive throughout its entire range that full accuracy is maintained even on narrow scales, and its speed, when used in a socket, is equal or superior to that of a thermocouple similarly protected. Write for full details. **The Foxboro Co., 190 Neponset Avenue, Foxboro, Mass., U. S. A.**

*Trade Mark

FOXBORO INSTRUMENTATION

REG. U. S. PAT. OFF.



OIL-CRACKING HEAT AND CORROSION are not problems for ENDURO Stainless and Heat-Resisting Steels. Expansion joints, cracking stills and tubes, pumps, valves, sludge tanks, swing lines, heat exchanger and condenser tubes, vapor risers, still linings, bubble caps and trays—are *naturals* for ENDURO.

Enduro-THRIFTY METAL OF 10,000 USES

HIGH HEAT and CORROSION MEET THEIR MATCH

Heat that might wilt less sturdy materials and corrosive agents that might destroy find their match in Republic ENDURO Stainless and Heat-Resisting Steels. Even in the giant throat or expansion joint of cracking units, where both heat and corrosion are at their peak, ENDURO neither flinches nor weakens. Because of its high strength-to-weight ratio, lighter and more flexible construction also is possible.

ENDURO-made equipment can be counted on for fewer production interruptions and for substantially lengthened equipment life. While somewhat more expensive than less resistant materials, the initial cost is equalized by lower maintenance cost and higher continuous productivity. Its longer life makes it economical in the long run. It is the "thrifty" metal!

There are many ENDURO analyses, each designed to meet specific application needs. Talk with your equipment manufacturer or write for details to—

REPUBLIC STEEL CORPORATION

Alloy Steel Division • Massillon, Ohio

GENERAL OFFICES • CLEVELAND 1, OHIO

Export Department: Chrysler Building, New York 17, New York

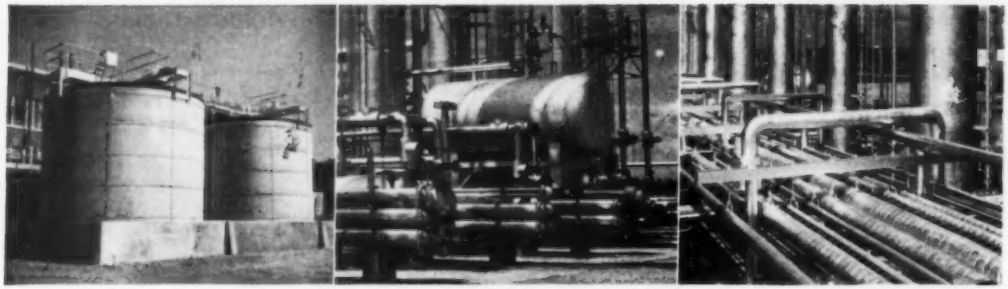
Enduro **STAINLESS STEEL**

REG. U. S. PAT. OFF.

REPUBLIC STEEL

✓ **Check ALL 12 advantages:** • RUST AND CORROSION-RESISTANCE • HEAT-RESISTANCE • HIGH MELTING POINT • LOW COEFFICIENT OF EXPANSION • HIGH STRENGTH • GOOD DIMENSIONAL STABILITY • NO METALLIC CONTAMINATION • EASY TO CLEAN • EASY TO FABRICATE • EYE APPEAL • LONG LIFE • LOW END COST

Why ZEROLITE is the outstanding cold insulation...



. . . for tanks . . . equipment . . . pipes

Here are 4 outstanding qualities which make this new *inorganic* insulation the choice for so many low temperature services: (1) high fire resistance (2) low heat conductivity (3) excellent moisture resistance (4) immunity to attack and damage by many solvents.

Because of these advantages Zerolite* is particularly recommended for locations where the fire problem is dominant; where solvent fumes may cause costly deterioration of an insulation, and where low heat conductivity is essential in systems working at temperatures as low as 400F.

Zerolite is made from mineral wool processed with a special binder to make it exceptionally resistant to moisture. It is manufactured in sheet, lagging and pipe insulation form . . . in a variety of sizes and thicknesses. The pipe insulations are further protected with an asphalt saturated asbestos felt which reduces the need for seam filling and speeds installation.

Reg. U. S. Pat. Off.

ZEROLITE IS RECOMMENDED FOR:

- Petroleum dewaxing equipment
- Gas purifiers and condensers
- Chillers and exchangers
- Chemical process lines
- Pharmaceutical process equipment
- Reactors and economizers
- Solvent storage and piping
- Ammonia lines
- Cold tanks and vessels
- Cold water lines
- Freon lines
- Air conditioning equipment

SEND FOR FOLDER

A copy of this new Zerolite folder is yours for the asking. Write Johns-Manville, Box 290, New York 16, N. Y.

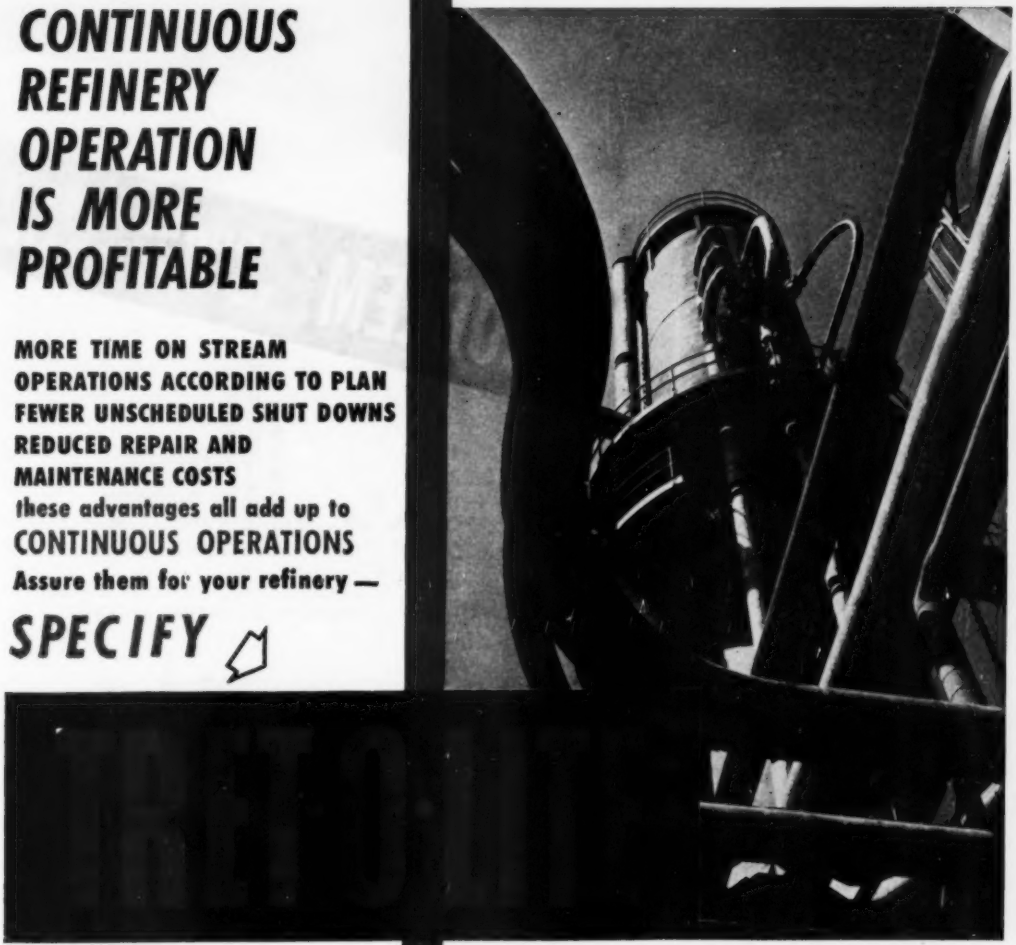
Johns-Manville ZEROLITE

REFRIGERATION INSULATION

CONTINUOUS REFINERY OPERATION IS MORE PROFITABLE

MORE TIME ON STREAM
OPERATIONS ACCORDING TO PLAN
FEWER UNSCHEDULED SHUT DOWNS
REDUCED REPAIR AND MAINTENANCE COSTS
these advantages all add up to
CONTINUOUS OPERATIONS
Assure them for your refinery—

SPECIFY



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...helps refiners to maintain a continuous schedule of operations by preventing frequent shut-downs due to salt plugging and hard coking, and by helping to curtail corrosion damage. Many leading refiners rely on Tret-O-lite for efficient salt removal—for complete information, write or call

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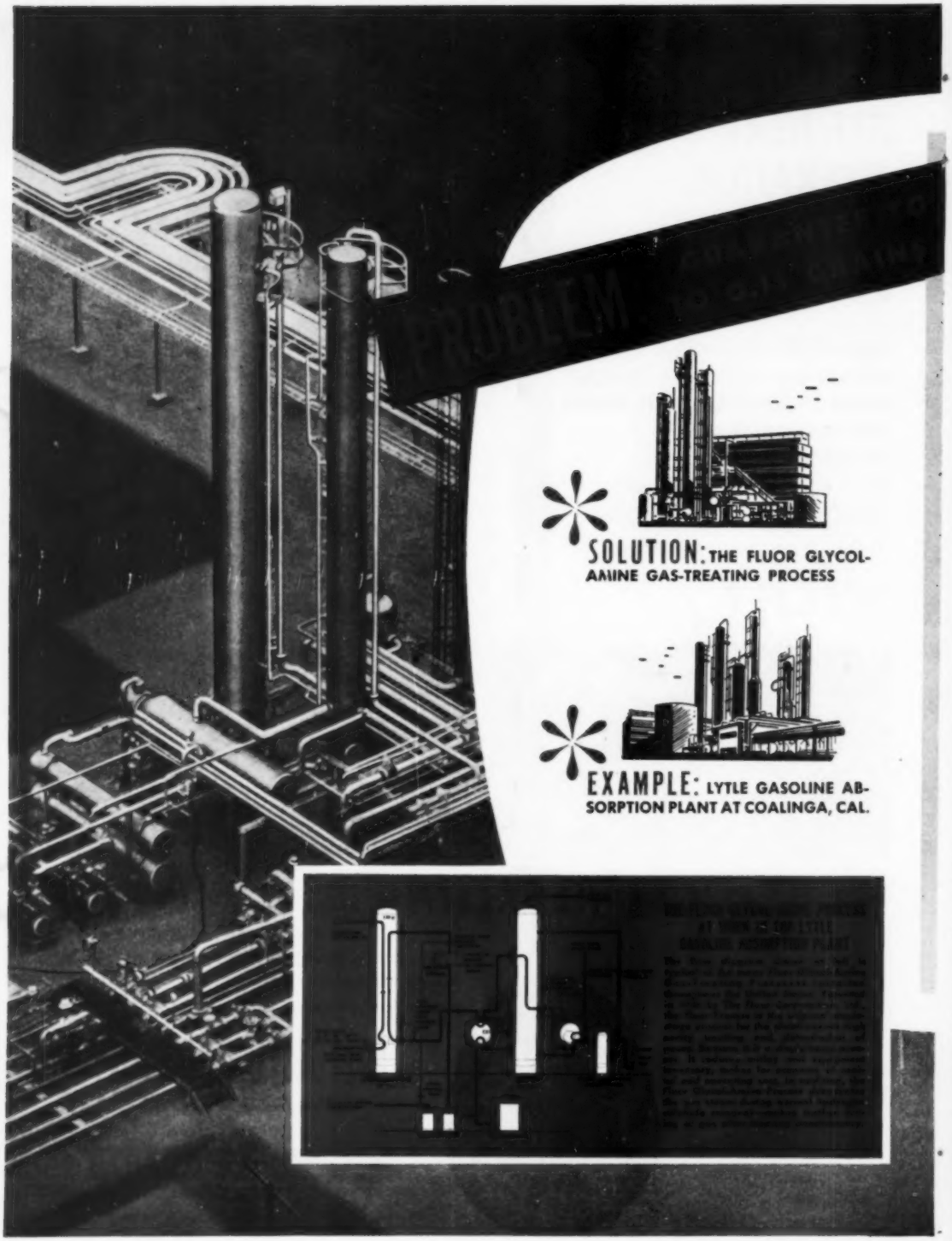
DESALTING DEHYDRATING

TRO-49-2


SOLUTION: THE FLUOR GLYCOL-AMINE GAS-TREATING PROCESS
EXAMPLE: LYTLE GASOLINE ABSORPTION PLANT AT COALINGA, CAL.

The Lytle Gasoline Absorption Plant at Coalinga, California, is a story of the Fluor Glycol-Amine Gas-Treating Process at work.

Expansion of natural gas supply through deeper drilling introduced into the Lytle Plant a natural gas so high in hydrogen sulphide content that it was no longer acceptable as commercial sales gas. After processing for gasoline recovery, the discharge gas was analyzed and found to contain 1.25 grains of hydrogen sulphide per 100 SCF and up to three-fourths of 1 mol per cent of carbon dioxide. Even though this gas was sufficiently pure for sale in many areas, in this particular instance requirements for commercial gas were set to *not more than 0.15 grains of hydrogen sulphide per 100 SCF*... a purity requirement so stringent that it would only be attempted by Fluor Gas Processing Engineers using the Fluor Glycol-Amine Gas-Treating Process.

Following study of the requirement by Fluor, a Research Department pilot plant was set to run at gas composition and operating conditions simulating those at the Lytle Plant. Here it was *proved* the Fluor Glycol-Amine Gas-Treating Process could meet—*and exceed by a comfortable operating margin*—the 0.15 grain per 100 SCF requirement efficiently, economically, and on a guaranteed basis.

The plant for the Lytle job was then designed on the findings of the Fluor Research Department. Engineering was set in motion, and a field construction schedule formulated.

The Lytle unit is a "sweet"-running unit paralleling laboratory and pilot plant findings—meeting its guaranteed performance with an adequate margin. This new installation raises the total installed capacity of Fluor Glycol-Amine Gas-Treating Plants to 585,000,000 SCF/D.

Fluor invites owners and operators of gas-producing properties to submit their gas-treating problems for study and recommendation by Fluor's Gas Processing and Research Engineers. Let them study *your* particular problem—the range of purity obtained through use of the Fluor Glycol-Amine Gas-Treating Process is virtually unlimited. It may be the low-cost answer to your gas-treating problem.

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Designers and Constructors of Refinery, Chemical and Natural Gas Processing Units.

Manufacturers of Cooling Towers, Fin • Fan Units, Mufflers, Gas Cleaners, and Pulsation Dampeners.

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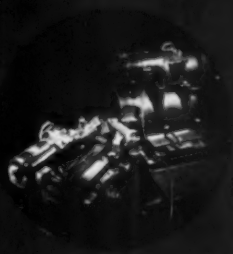


On thousands of applications, stepless variable speed operation assures exactly the right speed for every operation . . . for each operator . . . the right speeds for each change in the consistency or shape of the material being processed. Such variable speed operation pays off in higher rates of production, a better quality product and more efficient performance of your equipment and your operators.

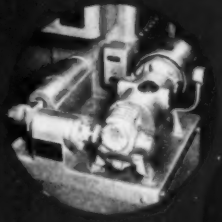
variable speed operation doesn't cost

IT PAYS

Master Speedrangers provide this infinitely variable speed in compact, all-metal, mechanical variable speed units in a wide range of types and sizes up to 5 horsepower.

See how the Speedrangers on the applications shown incorporate an electric motor, a variable speed unit, a gear reduction, and an electric brake . . . all standard Master units that easily combine into a compact, integral power drive. This provides exactly the right speed, the right features, in a unit that you can use right where you want it.

Write for Data 7525, a new 24-page book on Speedrangers, and see what a real job they can do for you.



MASTER SPEEDRANGERS

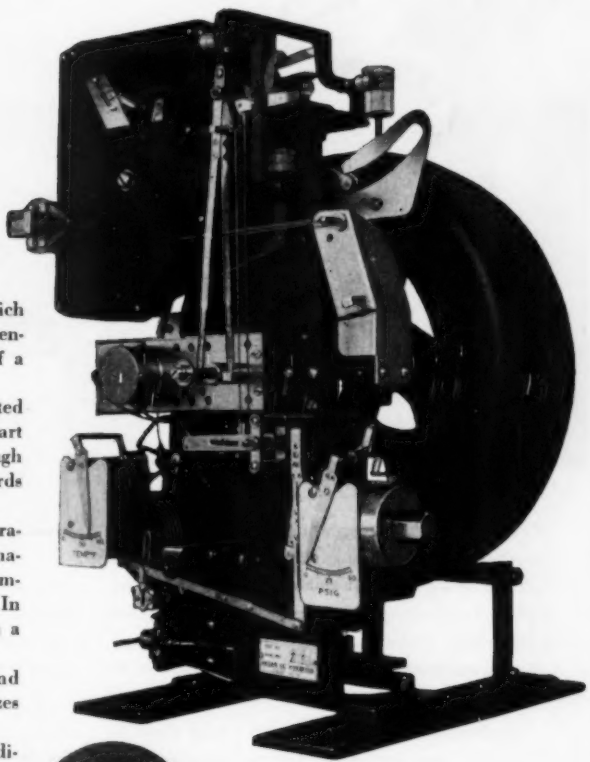
THE MASTER ELECTRIC COMPANY · DAYTON 1, OHIO

automatic compensation

FOR PRESSURE OR TEMPERATURE OR BOTH

with HAGAN

RING BALANCE FLOW METERS



When gas pressure departs from that for which the orifice was calculated, readings of conventional flow meters require the application of a "correction factor".

In Hagan Ring Balance pressure compensated flow meters, correction is automatic. The chart reading *is* the compensated reading, although both compensated and uncompensated records on the same chart can be obtained if desired.

This meter can also be supplied for temperature compensation, either alone or in combination with pressure compensation, and a temperature record may be added to the chart. In fact, a total of four records can be made on a single chart.

An integrator, operative between 2% and 100% of chart reading, automatically totalizes the compensated flow.

The Ring Balance principle makes the addition of pressure and/or temperature compensation so simple that it is a *standard model in the Hagan Ring Balance line*—not a special "problem child".

Measurement of gas flow is only one application of these extremely versatile meters. For full information on Hagan Ring Balance Meters or on specific metering problems write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN HALL BURDMIN CALGON

Pressure and temperature compensated Hagan Ring Balance Meter of the low pressure, low differential type. Differential may be as low as one inch of water.

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

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Hagan Building
323 Fourth Avenue, Pittsburgh 30, Pa.

Please send me further information on pressure and temperature compensated Hagan Ring Balance Meters.

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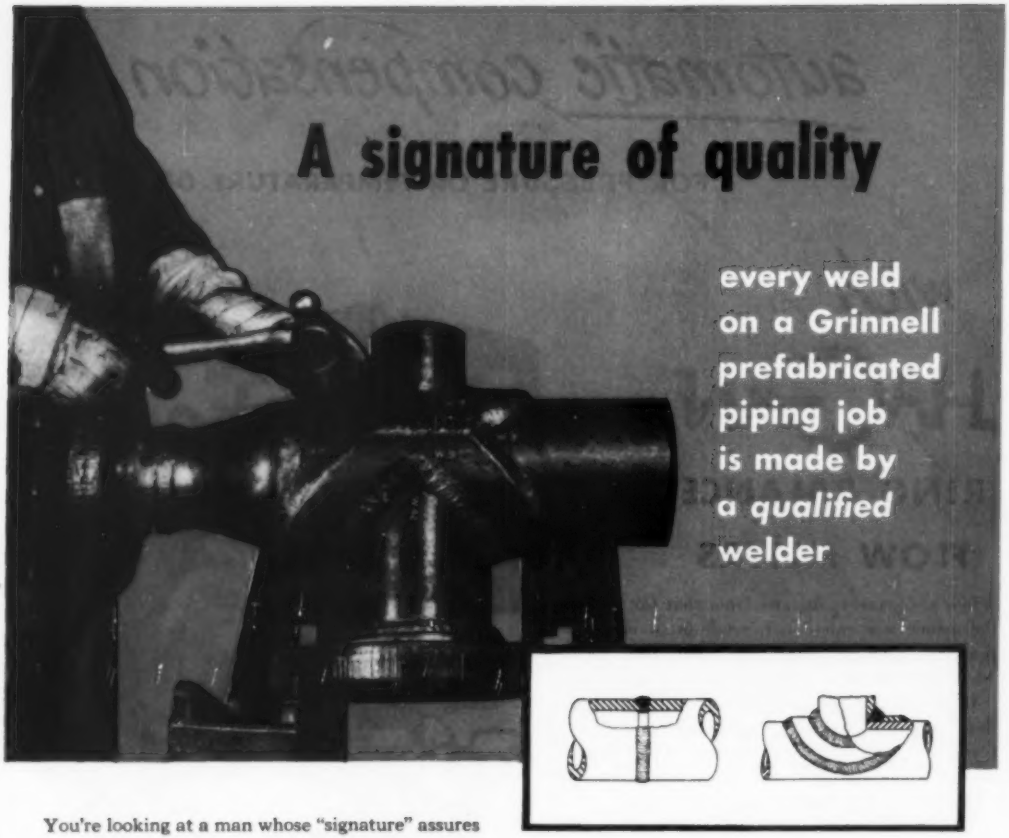
CITY _____ STATE _____

PR-7



You're looking at a man whose "signature" assures quality welding of piping. He's a Grinnell welder and, as every Grinnell welder, he is qualified by Grinnell according to a procedure which conforms to A.S.M.E. Boiler Construction Code, Section 9. After qualifying, he is given a number which he "signs" adjacent to each weld he makes.

Quality welding is only one of a long chain of responsibilities assumed by Grinnell on every prefabricated piping job . . . from the interpretive engineering to the on-time delivery of the fabricated piping. Such responsibility requires facilities for metallurgical research and testing, comprehensive knowledge of state laws and industry codes, and a complete familiarity with insurance company requirements for fabricated piping.

The fabrication of piping for today's high pressure, high temperature or corrosive services is a job for experts. It's a job for Grinnell prefabricating plants because Grinnell has the modern equipment and methods, and the skilled personnel which enable them to assume total responsibility for the job.

99 YEARS PIPING

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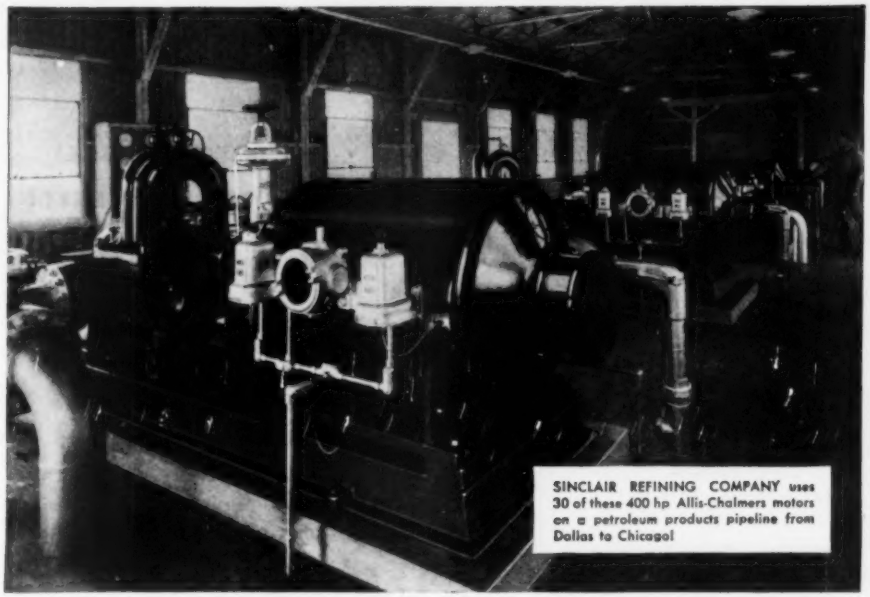
Grinnell Company, Inc., Providence, Rhode Island. Branches: Atlanta • Buffalo • Charlotte • Chicago • Cleveland • Cranston • Fresno • Kansas City • Houston Long Beach • Los Angeles • Milwaukee • Minneapolis • New York • Oakland • Philadelphia • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane

Underwriters' Laboratories INSPECTED MOTOR FOR HAZARDOUS LOCATION ELEC 10152 CLASS I GROUP D NO L

EXPLOSION-PROOF MOTORS TO 450 HP!

Higher Ratings In Similar Design



SINCLAIR REFINING COMPANY uses 30 of these 400 hp Allis-Chalmers motors on a petroleum products pipeline from Dallas to Chicago!

OVER ONE THIRD of Allis-Chalmers tube-type, explosion-proof motors have been purchased by 18 of the world's leading petroleum companies! . . . Proof that petroleum operators want these important features:

1. APPROVED BY UNDERWRITERS' LABORATORIES for ratings to *450 hp at 3600 rpm.* Motors of similar design are offered in larger sizes. This new, tube-type motor is the simplest explosion-proof design now offered in the very large sizes.

2. MOTOR IS SELF-CLEANING because of straight flow of cooling air — avoiding hidden recesses encountered in usual designs. If unusual operating conditions make cleaning desirable, motors can be cleaned while in operation — simple as cleaning your shotgun with a ramrod!

3. QUIET OPERATION because of improved fan design . . . straight flow of cooling air . . . smaller quantity of cooling air required by effective radiation system.

4. LIGHTER WEIGHT, YET MORE EFFICIENT! Elimination of heavy shell castings reduces motor weight . . . no sacrifice of electrical performance.

You'll want more information on how this *new* motor can help save maintenance dollars! Send for Bulletin 51R7149.

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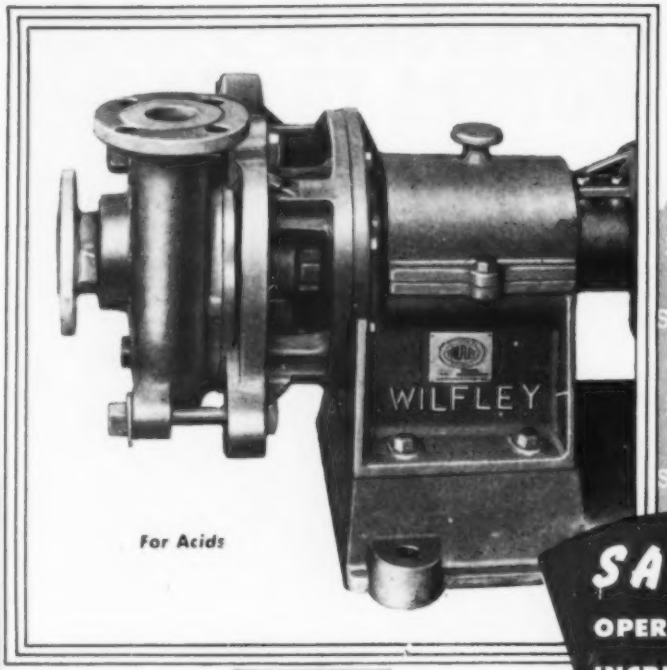
A-2760

Power, Electrical, Processing Equipment for Petroleum Industry

TURBINE-GENERATORS · BLOWERS and COMPRESSORS · TRANSFORMERS · UNIT SUBSTATIONS · MOTORS—*TEXROPE* DRIVES-CONTROL · CENTRIFUGAL PUMPS



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HOT LIQUIDS •

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SAVE

OPERATING COSTS *with*

INCREASED EFFICIENCY

CORROSIVES

A Companion to the Famous WILFLEY Sand Pump

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Buy WILFLEY for Cost-Saving Performance

Every day, modern chemical plants all over the world are proving by actual experience that WILFLEY Acid Pumps effect a substantial saving in operating costs. These famous pumps handle acids, corrosives, hot liquids and mild abrasives on a trouble-free, 'round-the-clock schedule *without attention.* Exclusive features of design and construction make WILFLEY the dependable pump that delivers cost-reducing performance on every job. 10- to 2,000-G.P.M. capacities; 15- to 150-ft. heads and higher. Individual engineering on every application. Write or wire for specific information.

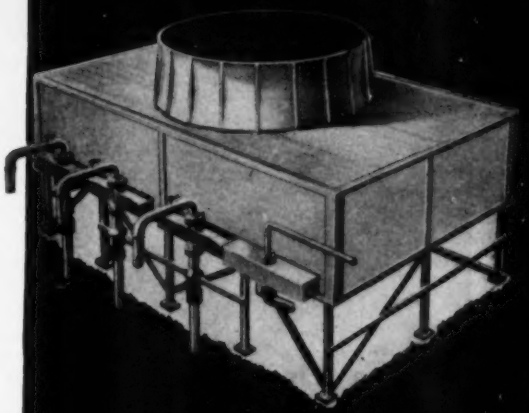
A. R. WILFLEY & SONS, INC.
DENVER, COLORADO, U.S.A.
NEW YORK OFFICE: 1775 Broadway, New York City

WILFLEY *Acid* PUMPS

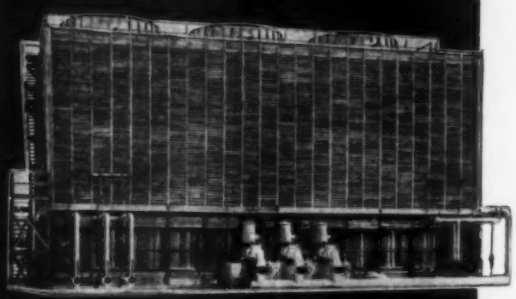
DriCooler*

- Finned tube air cooled units.
- Available with various fin and tube materials, sizes, and designs.
- Sized from small portable field units to large capacity, heavy industrial types.
- Induced or forced draft design with all parts accessible for flexible operation and easy maintenance.
- Structures of all steel or sheet-asbestos covered redwood.
- Marley fans, drive shafts, and Geareducers field proven in over a decade of use.
- Exceptionally low cost . . . guaranteed performance.
- Especially designed for cooling engine jacket water, lube oils, high pressure gases, steam condensing and similar applications.
- Ask for Bulletin DC-49.

*DriCooler is the exclusive trade-mark of The Marley Company, Inc., and is used to designate its finned tube dry surface cooling equipment.



WHICH DO YOU NEED?



Water Cooling Towers

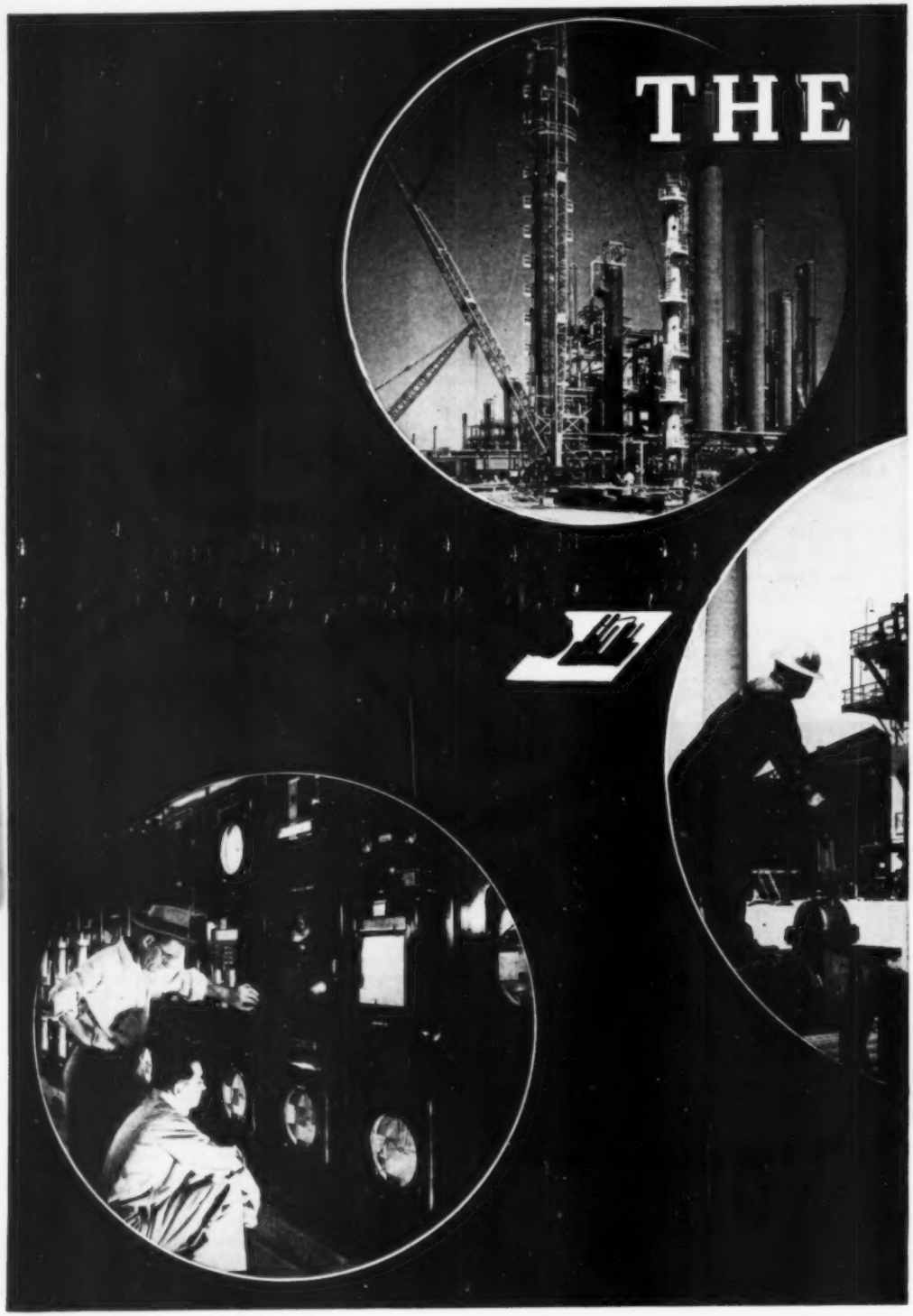
- Complete range of sizes, designs and materials.
- Mechanical Draft or Natural Draft; Cross-Flow or Counter Flow; wood, steel, or transite cased.
- Famous cooling tower trade names such as Aquatower, Double-Flow, Verflow.
- Exclusive Marley-designed, Marley-made fans, drive shafts and Geareducers.
- Accessible parts for flexible operation and easy maintenance.
- Meet every water cooling need with top performance and low cost.
- Available with atmospheric sections for the indirect cooling of fluids.
- Ask for Bulletin G-48.

WHY GUESS WHICH IS BEST... Marley designs both, manufactures both, and sells both so a fair and impartial analysis of your cooling problem can be made, based on your needs—not upon the manufacturers ability to supply.

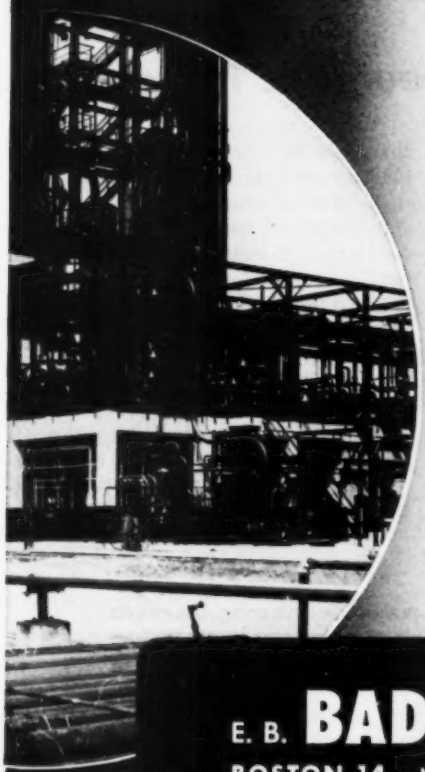
Every day new money-saving applications for both types of equipment are worked out by Marley "double trained" engineers. To keep abreast of the latest developments and to make certain you get the kind of cooling equipment you need ask The Marley Company, Inc., to send a "double trained" Marley application engineer to help you solve your industrial cooling problem. There is no cost or obligation.

MARLEY

THE MARLEY COMPANY, INC. • KANSAS CITY 15, KANSAS


THE

CRITICAL APPROACH



Badger's approach to plant design, whether the process is long established or newly developed, is one of critical analysis. Badger believes that the manufacturing methods of the petroleum and chemical industries should and will be always in a state of evolution and betterment. Through the critical approach — the constant intelligent and questioning review of methods, materials and equipment — Badger is often able to produce improved or simplified designs, which result in operating economies or more dependable plant performance.

E. B. **BADGER** & SONS CO. Est. 1841

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A SUBSIDIARY OF STONE & WEBSTER, INC.

You Get All 3

ACCURACY . . .
FLEXIBILITY . . .
RUGGEDNESS . . .

in the REPUBLIC Pneumatic Transmitter

When selecting a meter, whether it be for the measurement of flow, pressure, liquid level or liquid density, the experienced operator looks for these three important features.

He wants a meter that will give him accurate readings. He wants a meter that can be easily adapted to widely varying conditions. He wants a meter that is rugged enough to remain in service even under adverse operating conditions.

The Republic Pneumatic Transmitter has a guaranteed accuracy of within ½ of 1% of the transmitter range. This is higher than can be consistently secured and maintained with any other method. By making a few minor adjustments or substituting a few small parts its operation can be easily changed to any desired range between a minimum of 0—0.6" of water to a maximum of 0—704" of water. Its construction is more like that of a precision machine than of the sensitive instrument that it is.

It is for these reasons that the Republic Pneumatic Transmitter, even though comparatively new, has already been specified and installed on over 2500 industrial metering applications.

★ ★ ★

The Republic Transmitter is a pneumatic metering device. It employs the force-balance principle to convert process variables such as flow, liquid level, pressure or liquid density, into air pressures which vary proportionally with the process variables.

These air pressures become direct measurements and can be conducted to reading instruments or used as the measuring impulse for the actuation of an automatic controller.

For complete details write for Data Book No. 1001

REPUBLIC FLOW METERS CO.
2240 Diversey Parkway, Chicago 47, Illinois

HERE IT IS!

...THE NEW MULTI-STAGE COOLING TOWER

...the Result of 10 Years of Research and EXHAUSTIVE TESTS

...FOR THE WORLD'S LARGEST LUBE PLANT

Top view of the 48'-0" wide x 408'-0" long x 28'-6" high, 34-cell, Multi-Stage Cooling Tower designed and erected for the World's Largest Lube Plant.

51,000 Gallons of water per minute . . . 3,060,000 gallons of water per hour . . 73,440,000 gallons of water per 24-hour day . . . cooled to a guaranteed temperature with this 34-cell Multi-Stage Induced Draft Cooling Tower.

NEW IN *ENGINEERING* . . . IN *PERFORMANCE* . . . *ADAPTABILITY*

The above installation represents not only new designing to meet the requirements of the Petroleum and Chemical Industries, but is the results of 10 years of research and testing to meet the trends towards higher efficiency in Cooling Tower performance with increased temperature ranges and closer approach to the ambient wet bulb temperature. Water Cooling Equipment Company Engineers have created the above Multi-Stage Cooling Tower which attacks a hard cooling condition and solves the problem by breaking it into easier cooling conditions which are easier to accomplish. It is, in effect, two or more Cooling Towers operating in series within a SINGLE enclosure and operated with a SINGLE pumping of the water. The internal arrangement provides the serial flow of all the water from one bank of Filling to another, permitting intimate contact with separate streams of outside ambient air in counterflow through each bank. The IMPORTANT factor in this Cooling Tower is..a high water-to-air ratio is maintained making it possible to increase greatly the enthalpy of the outgoing air over that even theoretically possible with the single pass arrangement in either counterflow or cross-flow Cooling Towers. This is an engineering triumph.

TODAY'S WATER COOLING PROBLEMS CANNOT BE SOLVED WITH YESTERDAY'S METHODS

WATER COOLING EQUIPMENT CO.

NEW HAMPSHIRE & FRISCO TRACKS • ST. LOUIS 23, MO.

FULL INFORMATION UPON REQUEST

Uniformly Better Filtering with Mt. Vernon Extra

Mt. Vernon Extra filter fabrics are made from top grades of cotton and produced under rigid laboratory controls . . .

The result is Mt. Vernon Extra's high degree of uniformity — for more thorough filtering—greater clarification of filtrates—more efficent recovery of solids . . .

Mt. Vernon Extra has the ruggedness required to take the rough scrubbing and scraping that's necessary in filter-fabric cleaning .

For fabrics that give you more thorough, more efficient filtering and longer wear, specify Mt. Vernon Extra.

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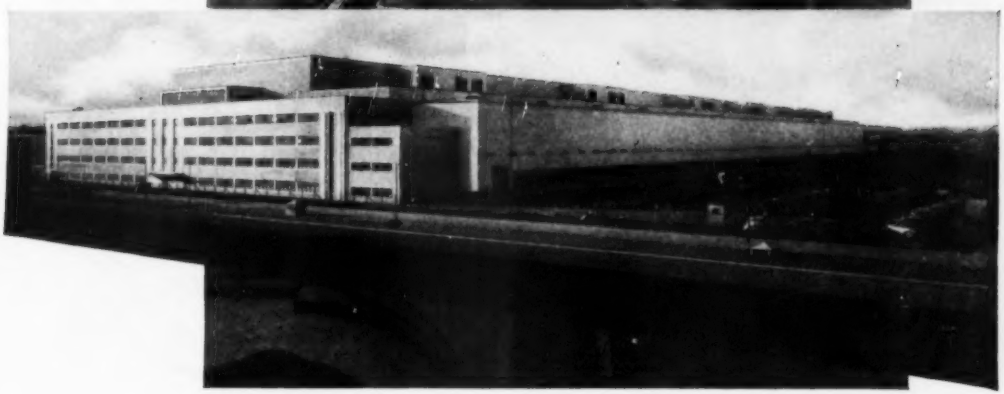
THE WORLD'S LARGEST TURBINE PLANT

Interior of General Electric Turbine Building, Heavy Equipment Area.



To meet the growing power demands of industry, General Electric Company retained Stone & Webster Engineering Corporation to design and construct at Schenectady, New York, its new turbine manufacturing plant.

The building, which is 650 feet wide by 1290 feet long, has a total floor area of more than 1,000,000 square feet. It required foundation construction of unusual design to carry the heavy loads to be superimposed on the manufacturing floor, which comprises nearly 20 acres.

This plant when in full production will be capable of producing each month enough turbine-generators to supply power and light for a city of a million inhabitants.

STONE & WEBSTER ENGINEERING CORPORATION

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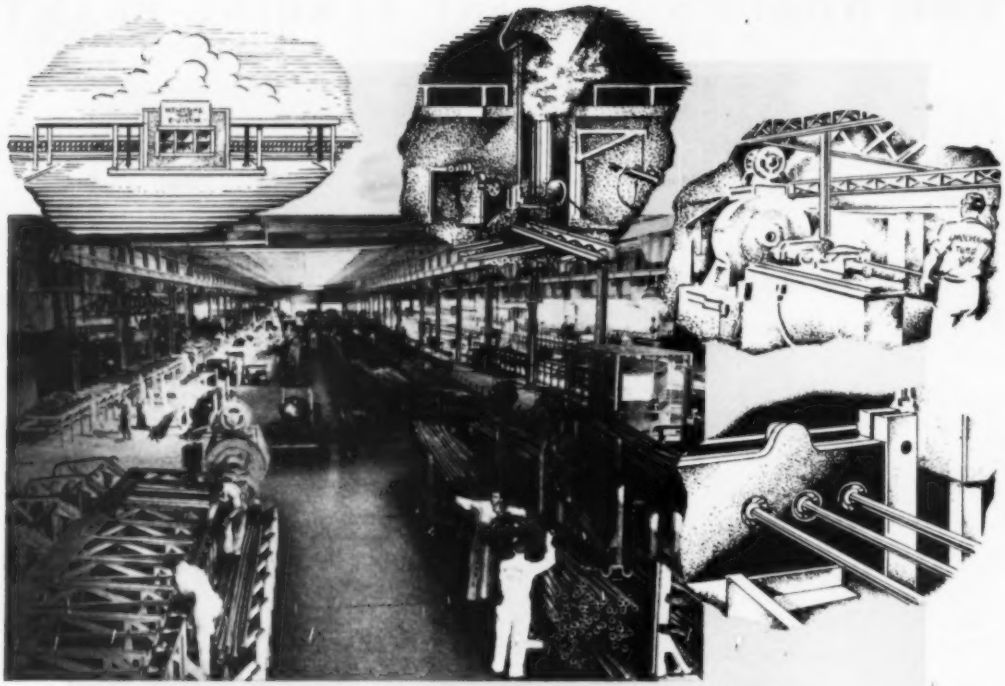

ORDER YOUR CONDENSER TUBES

from the most modern tube mill in the world

Located in the upper part of Alabama is the new mill of Wolverine Tube Division equipped to supply you with the finest seamless, non-ferrous tubing that science and skill can produce.

You can rely on the performance of Wolverine Tube because it is quality-controlled throughout its entire series of production steps—starting at the copper mines of our parent company, Calumet & Hecla Consolidated Copper Co., to the time it leaves our shipping dock.

Consult with Wolverine engineers regarding your next condenser tube installation.

WOLVERINE TUBE DIVISION
CALUMET AND HECLA CONSOLIDATED COPPER COMPANY
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MANUFACTURERS OF SEAMLESS NON-FERROUS TUBING

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New LE JONS BUBBLE CAP ASSEMBLY

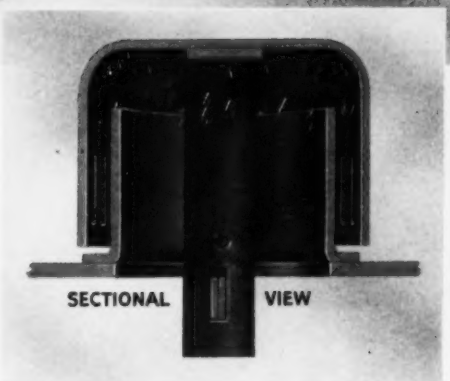
Saves 7 Ways

Unprecedented Simplicity
CUTS TRAY COST AND MAINTENANCE

Introduced a year ago by The Pressed Steel Co., the new Le Jons bubble cap assembly is proving a somewhat sensational source of savings in tray construction cost and maintenance. A survey of users shows these seven reasons why this simple new type of assembly is being increasingly specified:

1) Faster Assembly--no bolts or nuts, just hammer in wedges and bend over slightly to lock.
2) Perfect alignment of caps automatically.
3) Tighter Assembly--unit locked positively.
4) Stronger Trays, due to wedging action.
5) Eliminates costly flaring or welding of risers.
6) Less Maintenance, due to simplicity and tightness.
7) Ease of Replacement--just knock out wedges.

The cap, riser and yoke come weld-assembled ready for wedging into position in the tray.



We Can Save You Die Cost. Send for Data.

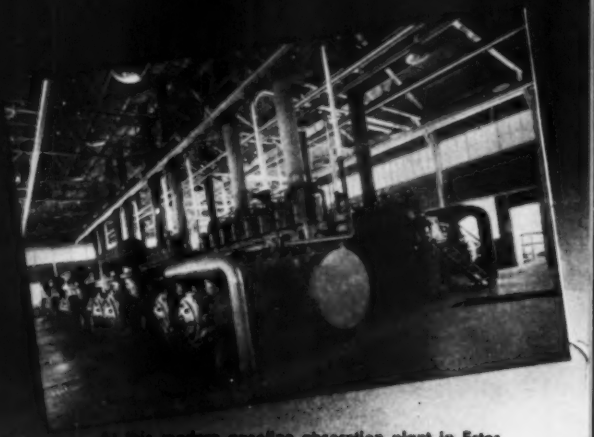
Assemblies are furnished in any workable metal, style and size of cap. Gages of metal in cap and riser to suit size. Made to suit tray plate thickness with or without gaskets. Yoke of 1/8" metal. Wedges of 12 and 14 gage. Send your blue prints or write for data. With dies on hand for over 150 styles of caps, we can probably save you this cost. Special caps promptly designed.

THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

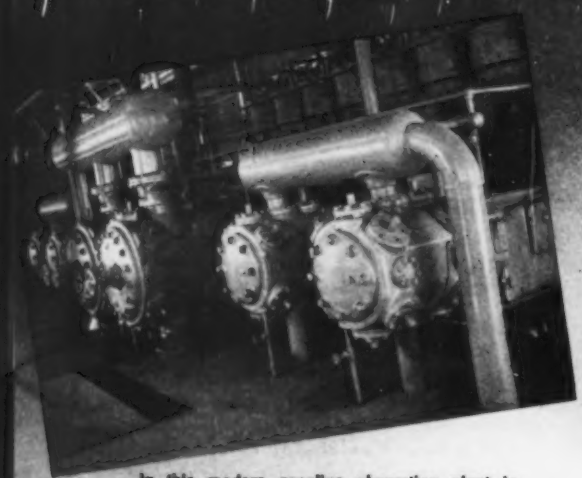
Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

☆ ☆ ☆ OFFICES IN PRINCIPAL CITIES ☆ ☆ ☆

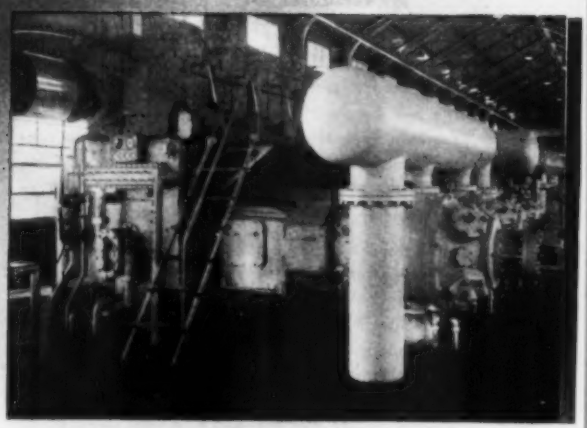
Conservation IS KEYNOTE



At this modern gasoline absorption plant in Ector County, Texas, gas is taken in from the field at pressures between atmosphere and 7 psig and compressed in two stages to a final discharge pressure of 205 psig. Compressor installation shown here consists of eleven Clark 800-BHP Right Angles.



In this modern gasoline absorption plant in Yoakum County, Texas, Clark Right Angle Compressors take gas from the field at pressures between atmosphere and 7 psig and compress it in two stages to 205 psig for processing.



Several producing companies co-operated on this joint conservation project in Texas. This fine, modern plant is equipped with Clark 8-cyl., 1600-BHP "Big Angles", shown above. Flare gas is compressed in three stages up to 1000 psi and discharged into a pipe line for transmission.

CLARK { **SETS THE PACE IN COMPRESSOR PROGRESS**

OF OIL AND GAS INDUSTRY

Probably the most important development in the petroleum industry in recent years is the spectacular progress made in conservation measures. Modern repressuring, recycling and gasoline absorption plants save untold quantities of gas and oil, both for current use and for the future, that would otherwise be wasted.

Clark Compressors are playing a major role in this great enterprise. In 1948, over 100,000 BHP of Clark units were installed in Texas alone, for use in conservation projects . . . Big Angles, Midget Angles and Right Angles.

Installed in an open field, this 800-[illegible] Angle" is one of three on this [illegible] for pressuring [illegible] keep up pressure. [illegible] is often called "the [illegible]

In this plant near Beaumont, Texas, natural gas is gathered from the field, compressed and then put through an absorption process and natural gasoline is extracted. Residue gas is then utilized. Compressors are Clark 8-cyl., 800-BHP Right Angles.

This Clark "Midget Angle" is used [illegible] conservation work. It lends itself to many field jobs where casing must be held down as close to the formation as is found to exist. Above—[illegible] "Midget Angle" skid-mounted, on gas lift service in the Hewitt Field, Texas.

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High efficiency—low pressure drop—for any temperature pressure condition including chemical reactions.

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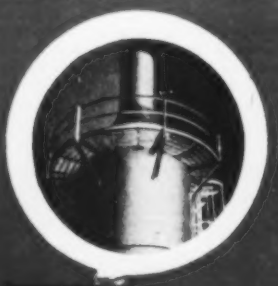

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They are the lowest-priced, full-port-area plug valves in their pressure and temperature range

And they *outlast* all other lubricated plug valves in their class. Every one of their many outstanding advantages including

100% area of standard pipe
100% lubricant seal around ports
Extreme economy of lubricant
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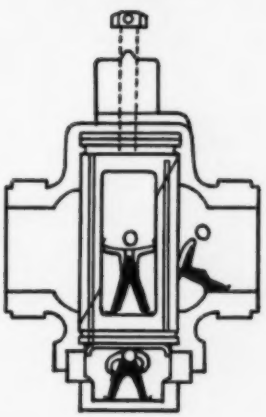
Self-sealing automatic adjustment for wear

. . . are features asked for by engineers and operating men of industry.

Proof of their long, economical, dependable performance has been established in practically every industry during the past seven years. And at their new low price, they are more than ever your lowest cost-per-year fluid control.

Why not send today for your free copy of Valve Reference Book No. 39-5? *It shows sizes, types and pressure ratings for Homestead-Reiser Valves.*



How the "*Self-Sealed*" Principle Works

In addition to a full lubricant seal around the ports and around the top and bottom of the valve, the wedge-action of the plug under line pressure, constantly presses the finely-finished surfaces of the plug outward against the seating surfaces of the body. This self-sealing action keeps the plug surfaces in contact at all times with the mirror-like bore of the body. The plug thus automatically adjusts itself for wear, assuring extra long life and maximum leakless service.

Write today for Reference Book 39—Section 5

HOMESTEAD VALVE MANUFACTURING CO.

"Serving Since 1892" P. O. Box 16, Coraopolis, Pa.

Deep Rock Modernizes Cushing Refinery

By W. J. Carthaus

Vice President in charge of Manufacturing and Research, Deep Rock Oil Corporation

THE installation of a 5,000 barrel fluid catalytic cracking unit at our Cushing, Okla., refinery will be one of the major steps in a program of modernization and expansion which is designed principally to produce superior quality products and more efficiently. Doing this will enable us to satisfy the requirements of any internal combustion engine likely to be produced commercially for some time.

W. J. Carthaus

Deep Rock pioneered in thermal cracking in the Mid-Continent field more than a quarter century ago with one of the earliest installations of a thermal unit designed by Universal Oil Products Company. The new fluid catalytic cracking unit, which will include a gas concentration system and feed preparation facilities, is being designed by UOP.

Single Column Unit

The cat cracker will follow UOP's improved design with reactor and regenerator incorporated in a single column. It will produce catalytically cracked gasoline, domestic burner oil and cycle stock. In addition, crude facilities will be increased through the installation of a crude distillation unit.

The gas concentration system will depropanize and debutanize the catalytically cracked gasoline, and at the same time prepare feed stock for the catalytic polymerization unit. The feed preparation system for the cat cracker will consist of a combination of vis-breaking and vacuum distillation designed to give maximum flexibility.

It is interesting to note that the installation of the cat cracker will not mean the retirement of the thermal cracking plant from service, although its operation will be modified.

The present thermal cracker is a two-coil unit with rated capacity of 5,000 barrels per day. Under the new set-up the heavy oil heater will be converted to vis-breaking service as part of the cracker's feed preparation system and the light oil heater will be changed for single coil operation to crack the heavy cycle stock from the cat cracker if that should prove desirable, as well as any other available cracking stock.

To Double Poly Unit

We have at the present time, a catalytic polymerization unit which processes the gas from the thermal cracker. It

(Advertisement)

will be necessary to practically double the capacity of the poly unit, now producing about 160 barrels per day of 82 octane (Motor Method) polymer gasoline, in order to take care of the additional gas produced in the cat cracking operation. When increasing the size of this poly unit, additional provision will be made for the recovery of propane and butane from the poly plant effluent, to be marketed as LPG. The LPG facilities will utilize, in addition to two new vessels, two existing flash chambers which were formerly part of the original small thermal cracker.

Expansion of our crude capacity and the installation of the cat cracker, necessitates considerable change throughout the plant. All main transfer lines will be replaced with lines of greater capacity and 200,000 barrels of additional tankage must be constructed. To maintain a constant check on our increased operations, and to assure uniform high quality, we plan to virtually double the size of our control laboratories.

More steam is another necessity and our plans call for the installation of an additional boiler to deliver 40,000 pounds of steam per hour. We are also confronted with a great increase in our water requirements. Our boiler feed water, presently amounting to 350,000 gallons per day, will be raised to about 500,000 gallons, all drawn from the Cushing municipal system.

Complete cooperation on the part of the city has been pledged and we are assured of the additional 150,000 gallons we will need. Our process cooling water is drawn from the Cimarron River and it will be necessary to enlarge our lines and pumping facilities to handle an increased volume of water.

Enlarged Modern Office Building

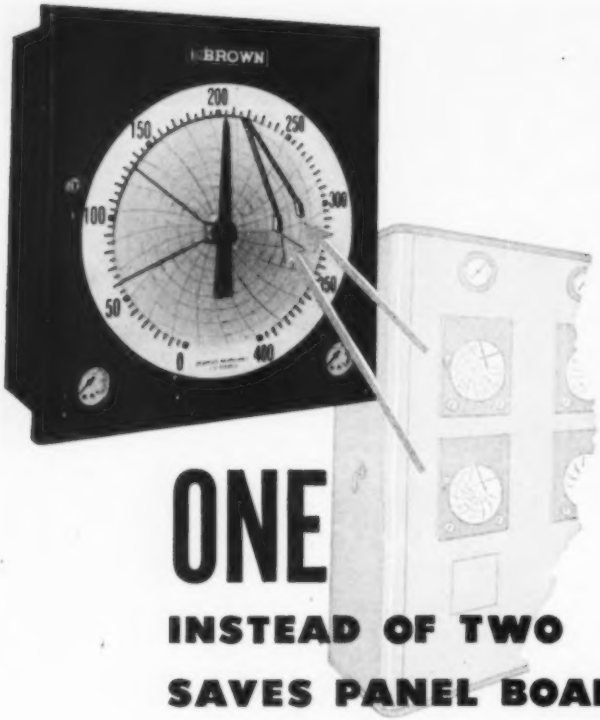
Better working conditions for our refinery office staff are being provided and the existing building is being greatly enlarged and completely modernized. Plans call for the installation of the latest type of air conditioning throughout the building.

New Research Laboratory

One part of our expansion program which we consider of major importance is the construction of an air conditioned building to house a research and development laboratory. This is to be entirely independent of the control laboratory so that research men will not be diverted from their work for plant trouble shooting or to solve purely operational problems. This research and development service will be divided into four parts including research, technical service to customers, new product development and engine laboratory research on fuels and lubricants.

The Cushing refinery is located on the Great Lakes pipeline and our gasoline moves to market in that way. Many of our special products such as technical naphthas and lubricating oils, however, must be transported by rail. To facilitate the loading of such products we are replacing our present loading rack with a more efficient installation.

(Advertisement)



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INSTEAD OF TWO

SAVES PANEL BOARD SPACE . . .

You get temperature and flow (or pressure) at a single glance

with the *ElectroniK* Recorder-Controller

Related data are recorded on one, double range chart. You don't need two charts to get related readings of a process.

One pen, which controls the temperature, is connected to a thermocouple. The other pen is connected, pneumatically, to a remotely located sensing device . . . to record the other variable that means most to you.

You get the convenience of two records on one chart *plus* temperature control *plus* the economy of using one instrument for two jobs. The *ElectroniK* Potentiometer does the trick . . . with the same top-quality performance and minimum maintenance that have made it famous throughout industry.

Call in your local Brown engineer for detailed information, today . . . or write for your copy of Catalog 15-4R for general information on the ElectroniK Air-O-Line Controllers.

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Advanced Instrumentation

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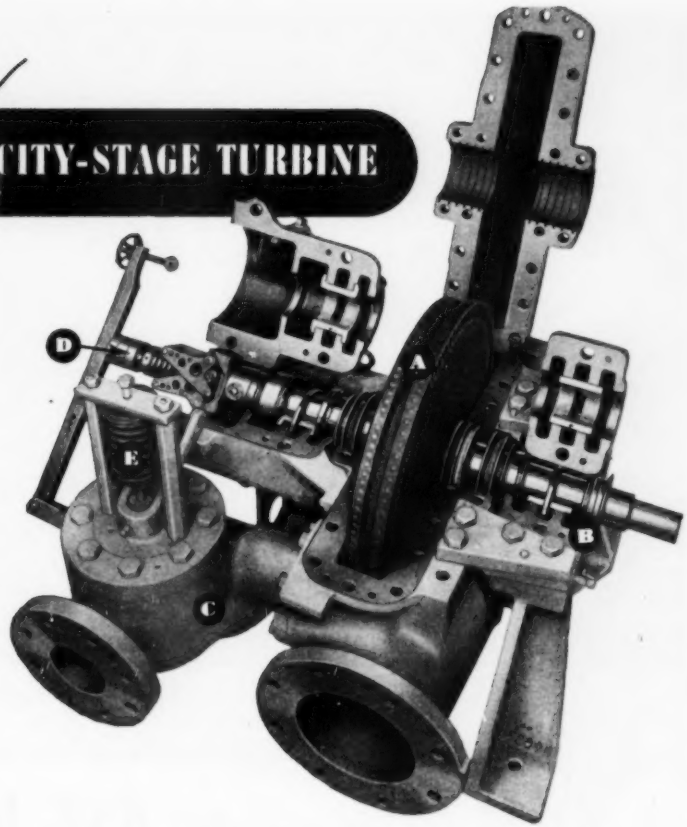
DE LAVAL VELOCITY-STAGE TURBINE



A *Improved bucket and nozzle ring design,* for high efficiency.

B *Center line support and flexible mountings,* to avoid misalignment from thermal expansion.

C *Steam chest in lower half of casing,* to permit removal of casing cover without disturbing piping.

D *Improved speed control.* Balanced regulating valve and direct acting governor permit close speed regulation. Speed can be varied readily while turbine is running.

E *Separate trip mechanism* and emergency closing valve, operated by speed governor independent of speed regulating valve.

And many other improved features.

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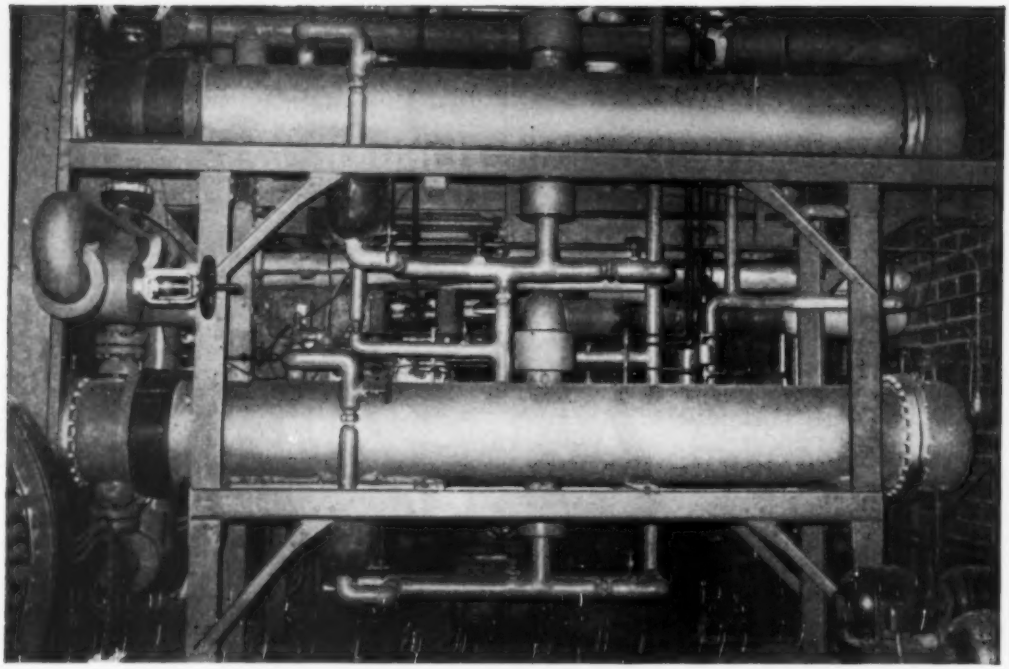

K&M "Featherweight" 85% Magnesia Insulation is used on piping and heat exchangers in this compressor room.

Heat...and cold cash...conserved by

K&M *"Featherweight"* 85% MAGNESIA

Basic Carbonate of Magnesia is combined with Asbestos Fibre in K&M "Featherweight" insulation. Its use on steam pipes and throughout heat exchanger systems is supplying particularly good proof of a whole series of economies that users enjoy...

(1) The highly effective insulation *piles up fuel savings.*

(2) Extreme lightness and easy application *cut installation costs.*

(3) Lasting strength and efficiency mean *freedom from maintenance.*

All this is being demonstrated all the time, in process plants, power plants and on other industrial applications where the heat-saving responsibility belongs to K&M "Featherweight".

You can get K&M "Featherweight" 85% Magnesia in all standard sizes. It is designed for temperatures up to 600°F.

There are K&M Distributors at strategic points throughout the country. They are experts on the application of this and all the other K&M insulation materials. One of them near you can help to make insulation more useful and profitable to you. Or write us.

K&M
Best in asbestos

Nature made Asbestos...
Keasbey & Mattison has made it serve mankind since 1873

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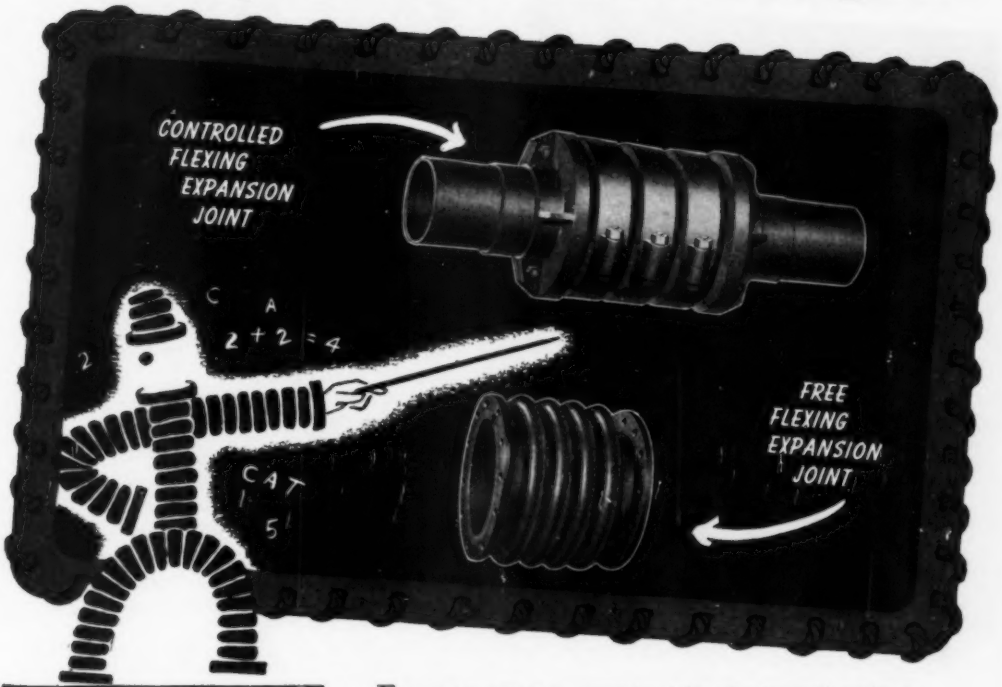
Let CMH simplify expansion control for you



CMH FREE-FLEXING EXPANSION JOINTS for pressures to 30 psi.; temperatures to 1400° F. Sizes to 24" I.D. Flanged or welding ends.

CMH CONTROLLED-FLEXING EXPANSION JOINTS with precision mated control rings for pressures to 300 psi.; temperatures to 1400° F. Sizes to 24" I.D. Flanged or welding ends.

SPECIAL CMH EXPANSION JOINTS for higher pressures can be furnished. Recommendations will be made on receipt of installation details.

For most installations, expansion joint selection need not be a complicated task. CMH has reduced the expansion joint selection problem to a matter of charts from which the joints necessary to meet your requirements may be selected quickly and easily. For unusual installations CMH offers its "Engineered Application Service" in which competent piping specialists will analyze your problems and make recommendations.

Whether your requirements are "run of the mine" or "one in a million" . . . for a new installation or replacement of obsolete equipment . . . CMH will make it easier for you to get the *right* expansion joint.

The charts mentioned above plus additional application data are presented in Bulletin EJ-49. Write for copy.

CMH—ONE dependable source for every flexible metal hose requirement

• CMH manufactures all standard types of flexible metal hose, both convoluted and corrugated, in a variety of metals; expansion joints for piping systems; stainless steel and brass bellows; various conduits and special assemblies of these components.

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Leaders in the Science of Flexonics
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FLEXON . . . . . identifies CMH products which have served industry for more than 47 years.

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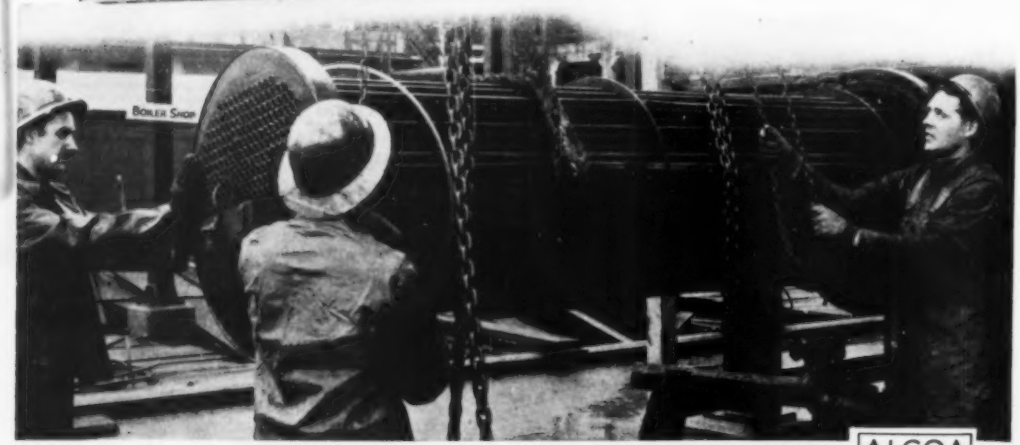
resist THE CORROSIVE BITE OF sour crude products

Install tube bundles of Alcoa Aluminum (A.S.T.M. Specification B234-48T) in your heat exchangers. They are unaffected by most refinery products including those of sour crude. Use Alcoa Alclad Tubes to resist most cooling waters. Installation is no problem. Use standard tools and procedures to roll-in.

Expensive? No . . . Alcoa Tubes cost ½ as much as Admiralty, ⅔ cold drawn seamless steel, ⅙ stainless or Monel. It costs nothing to learn more about them from the booklet, "Alcoa Aluminum Heat Exchanger Tubes". Ask your nearby Alcoa Sales Office for a free copy, or write ALUMINUM COMPANY OF AMERICA, 696G Gulf Building, Pittsburgh 19, Pennsylvania.



ALCOA ALUMINUM

HEAT EXCHANGER TUBES

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yield dividends in stainless welds

Every Arcos electrode is the product of careful testing and retesting during development, followed by the close adherence to specification for raw materials, and very strict application of quality controls in manufacturing.

THAT IS WHY Arcos electrodes, in the hands of a competent welder, give consistently sound, trouble-free welds.

THAT IS WHY Arcos electrodes deposit weld metal physically, chemically and metallurgically right for the job at hand.

THAT IS WHY every day of welding with Arcos electrodes *yields maximum production*. Costly non-productive time, chipping and rewelding or repairing weld failures is eliminated.

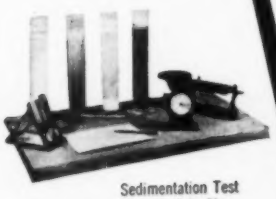
These are the reasons why the pound price of Arcos electrodes is not a true measure of the value of the welds developed from them.

•

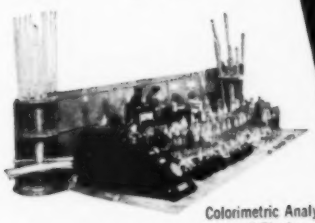
Use Arcos quality controlled stainless electrodes to keep your weld costs low.

•

Viscosity Test



Sedimentation Test for Particle Size

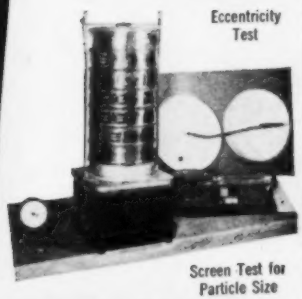


Colorimetric Analysis of Steels

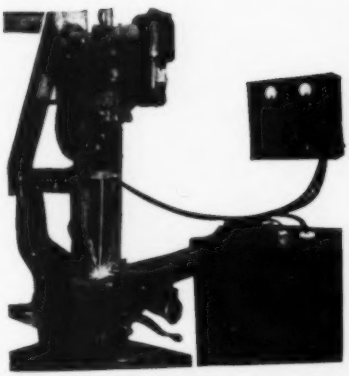
Bulk Test for Coating Materials

Ferro-Alloy Gassing Test

Eccentricity Test



Screen Test for Particle Size



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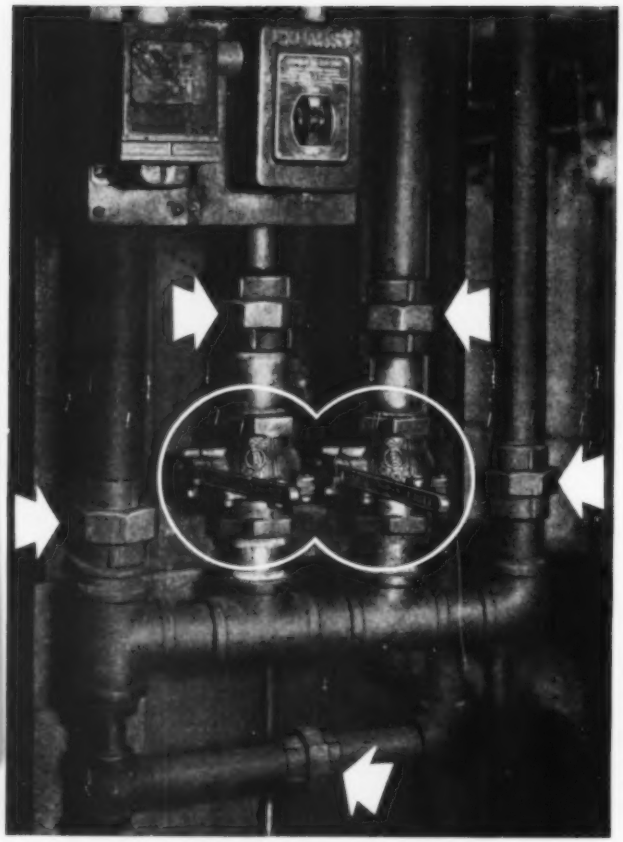

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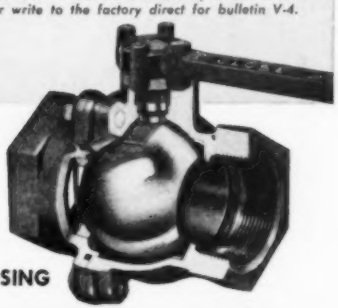
Ball Type
VALVES

. . . provide efficient, time-saving service on quenching lines for annealing furnaces at Revere Copper and Brass Incorporated.

In any plant, *it costs money to constantly repair or replace valves,* whether it's one or a hundred. Rockwood offers you a new ball type valve that is designed and built to cut maintenance costs, increase production output and give longer *leak-proof* service. Many plants like this one have found that Rockwood Ball Valves save time, cost less to operate, stay in service longer and give positive shut-off.

These two Rockwood Valves shown in the picture are opened and closed 60 times a day under 100 p.s.i. Unfiltered river water flows thru the valves and under this severe condition both valves have lasted *4 times longer* than any other make of valves. This same plant is also equipped with Rockwood Cold Forged Steel Unions. Rockwood Ball Valves are available in bronze in pipe sizes from ½" to 2" for 300 p.s.i. working pressure.

For further details and uses, see your distributor or write to the factory direct for bulletin V-4.



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2. LEAK PROOF SERVICE
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Pritchard's experience in the engineering and construction of LPG facilities ranges from smaller stand-by plants to large storage and terminal installations. A recently completed project, on the eastern seacoast, with a capacity of 3,000,000 gallons of propane, is shown in aerial view. The inset shows a typical LPG stand-by plant built for an eastern corporate utility.

All of Pritchard's Gas Engineering services are designed to give prompt and effective solution to your gas treating and gas handling problems—at the greatest possible savings to you. You, too, are invited to make full use of Pritchard's complete design, engineering and construction facilities on your next LPG installation. Write TODAY for complete information. No obligation.

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full use of maximum refining capacity

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PETRECO Electric DESALTERS assure maximum salt removal, because they are kept at top efficiency through PETRECO SERVICE, which also provides

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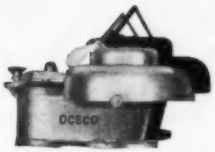
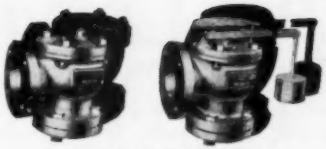
SPECIALIZED *Electric* PETROLEUM PROCESSES { DESALTING / DEHYDRATING

PR 49-3



V-113 VENT VALVES control tank breathing, minimizing vapor losses and deterioration of product. High flow capacity. 2" to 12" sizes. ½ oz. to 8 oz. pressure or vacuum settings.



V-103 VACUUM RELIEF AND V-106 PRESSURE RELIEF VALVES are furnished in 3", 4" and 6" sizes. Vacuum settings from 1½ oz. to 1 lb. per sq. inch. Pressure settings from 2 lbs. to 30 lbs. per sq. inch. Working temperatures up to 600° F.

V-114 INTERNAL TANK VALVES are provided with a fusible link that melts when subjected to fire, closing the valve instantly, and cutting off the flow from the tank. 3", 4", 6", 8" and 10" sizes.

TYPE "E" FLAME ARRESTORS can withstand long exposure to fire. The "banks" have vertical straight through passages—minimizing entrainment and pressure drop, and are "extensible" for easy cleaning. 2" to 10" sizes.

OCECO FITTINGS

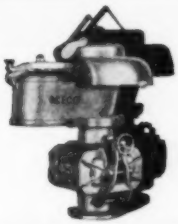
Prevent VAPOR AND FIRE Losses

● Oceco Vents eliminate the free discharge of vaporized liquids. They control tank breathing resulting from temperature changes and pumping – protect the quality of the stored product – and prevent "blow-outs" and "cave-ins". Oceco Flame Arrestors are a positive flame stop – they prevent explosions and fires.

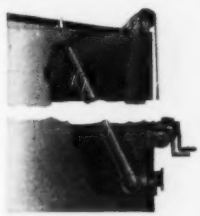
Specify Oceco Fittings *throughout* for *all* your tanks – and get proven, dependable, trouble-free protection for only a fraction of one per-cent of the value of the tank and its contents.

A few of the most popular Oceco fittings are illustrated and described briefly herewith. But send for the Oceco Data Sheets. They give full details and specifications, and complete listings of sizes, weights, dimensions, etc. Let the Oceco Engineers – pioneers in this work – help you equip your tanks for utmost safety and economy.

V-108 EMERGENCY PRESSURE RELIEF VENTS provide instant relief for excessive internal pressures, resulting from exposure fires, etc. Furnished in 6", 8", 10", 15¼" and 20½" sizes.



TYPE "BE" VENT UNITS consist of a V-113 Vent Valve with snuffer, mounted on a Type "E" "Extensible" Bank Flame Arrestor. 2" to 10" sizes. Unsurpassed for efficiency and reliability.



SWING LINE EQUIPMENT – complete facilities including heavy duty tank nozzle; efficient double elbow swing joint; swing pipe; cable clamp; cable; sheave bracket and internal or external winch.

V-109 STILL TYPE VALVES combine vacuum and pressure relief in a single valve. 3", 4" and 6" sizes. Pressure settings from 2 to 25 lbs. per sq. inch. Vacuum settings from 1 oz. to 10 oz. Temperatures up to 600° F.

SEND FOR THE OCECO DATA SHEETS. Ask for sheets on the individual fittings in which you are most interested, or send for the complete set. WRITE TODAY.

Oceco Division

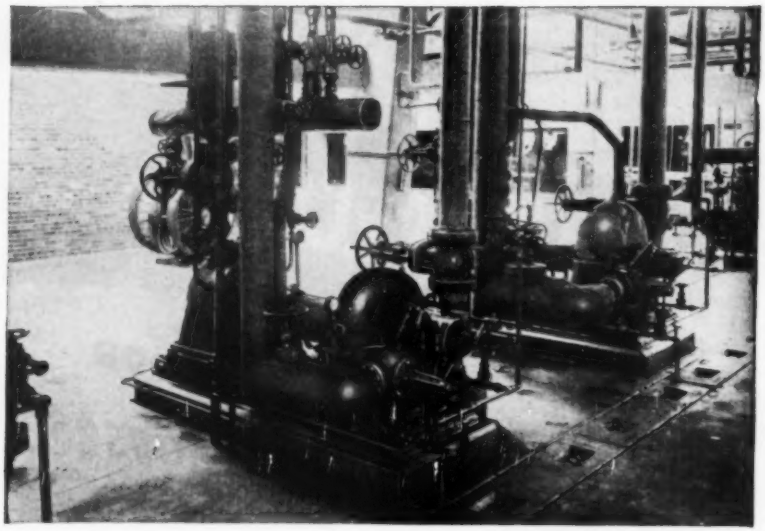
THE JOHNSTON & JENNINGS CO.

ENGINEERS J&J MANUFACTURERS

885 ADDISON ROAD CLEVELAND 3, OHIO

ENGINEERING AND SALES REPRESENTATIVES IN THE PRINCIPAL CITIES

TERRY



THE ROTORS OF THESE 75 H. P. TERRY TURBINES ARE DOUBLE RIM PROTECTED

The two 75 H.P. Terry Turbines shown above (in the plant of a leading refiner) employ the Terry Solid Wheel Rotor. The wheel is made from a single steel forging and the buckets are milled directly into the wheel. — All as shown in the illustration at the left.

The buckets are protected by rims at the sides of the wheel. These rims would take without damage any rubbing that might occur if the clearance became reduced.

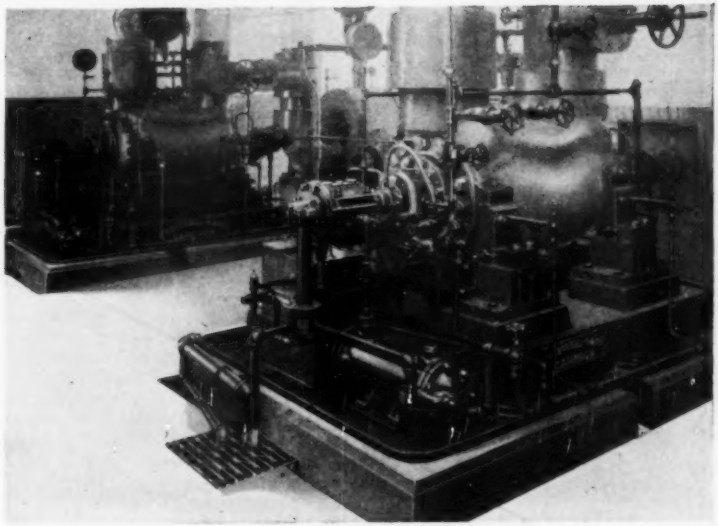
With this construction it is impossible for the blades to foul and frequent inspections of the thrust bearing are not required to obtain safe and dependable operation.

This feature and many others of the Terry Wheel Turbine are fully discussed in our Bulletin S-116.

T-1169

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

How much time do your refinery pumps save?



These two I-R hot-oil pumps at the Magnolia Petroleum Company's Beaumont refinery in Texas saved plenty of time—*maintenance time*. One pump operated over 12 years, the other 10 years, before being opened for inspection. And then only minor repairs were necessary to put them back on stream.

The record of these two pumps, both of which, since 1936, have been handling oil at 750°F against a high discharge pressure definitely proves the *"less time out for maintenance"* feature of Ingersoll-Rand pumps . . . a feature that helps to reduce over-all production costs. Under today's conditions, this feature is more important than ever.

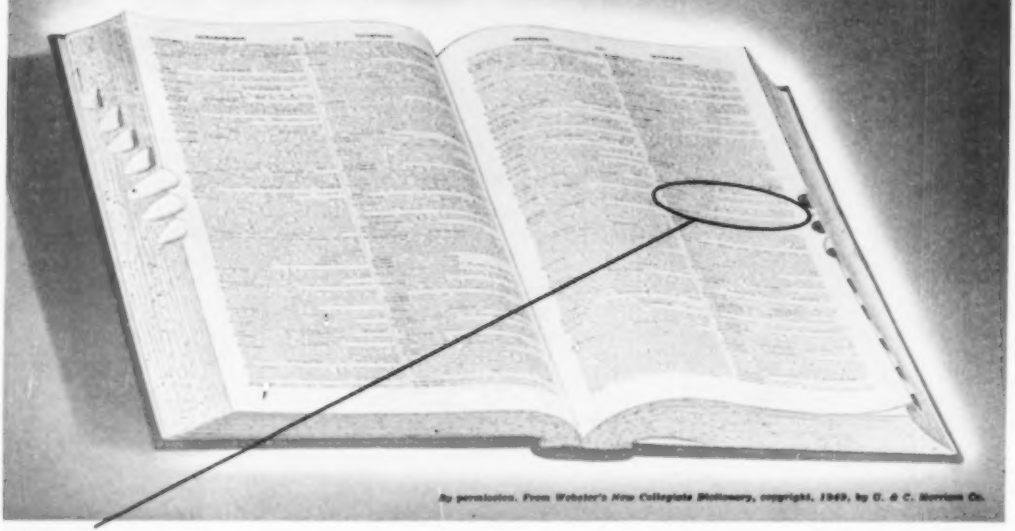
It's a good idea to confer with an I-R engineer before buying a pump for *any* refinery application. He'll be glad to point out the features of I-R pumps that mean year after year dependability . . . *and with the least amount of time out for maintenance.*

Ingersoll-Rand

Cameron Pump Division 405-10
11 Broadway, New York 4, N. Y.

COMPRESSORS • AIR TOOLS • JACKHAMERS • CONDENSERS • BLOWERS • PUMPS

Why We Say
CHEMICO PLANTS ARE PROFITABLE INVESTMENTS



Webster defines an investment as "the investing of money or capital for income or profit." In the heavy chemical field, Chemico is a proved translator of *investment* into profit. Here's why:

Every Chemico-built plant is planned and designed to fit individual needs.

Each plant is designed by engineers and technologists of recognized authority.

Chemico's advanced processes and selection of equipment insure high efficiency of operation...and, where necessary, new processes and facilities are developed to meet special circumstances.

Chemico brings to bear on each new project its 35 years of experience in constructing a wide range of heavy chemical installations.

Chemico turns the plant over to the purchaser only after over-all performance guarantees have been met. But initial performance is not enough. Chemico also trains the client's staff in every phase of operation.

Chemico takes full responsibility for the job... from initial investigation to completed project.

These are some of the reasons why owners have found that "*Chemico Plants are Profitable Investments.*"

Before deciding to build a new heavy chemical plant or remodel an old one, it will pay you to consult Chemico. CC 186

Typical Chemico Undertakings

PLANTS FOR PRODUCTION OF

SYNTHETIC AMMONIA
SYNTHETIC METHANOL
DOUBLE SUPERPHOSPHATE
AMMONIUM PHOSPHATE
AMMONIUM SULFATE
AMMONIUM NITRATE
CALCIUM NITRATE
FORMALIN

PLANTS FOR PRODUCTION, CONCENTRATION AND RECOVERY OF

HYDROCHLORIC ACID
NITRIC ACID
PHOSPHORIC ACID
SULFURIC ACID

CHEMICAL CONSTRUCTION CORPORATION

EMPIRE STATE BLDG., 350 FIFTH AVENUE, NEW YORK 1, N. Y.

EUROPEAN TECHNICAL REPRESENTATIVE
CYANAMID PRODUCTS, LTD., BRETTENHAM HOUSE, LANCASTER PLACE, LONDON W. C. 2, ENGLAND

EUROPEAN LICENSEE OF N. E. C. PROCESS
HYDRO-NITRO S. A., 8 QUAI DU CHEVAL BLANC, GENEVA, SWITZERLAND

CABLES: CHEMICONST, NEW YORK

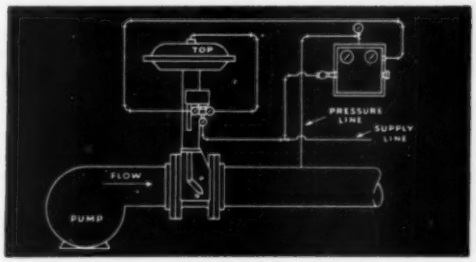
CHEMICO
CHEMICAL CONSTRUCTION

Chemico Plants are profitable investments

R-S valvEvents

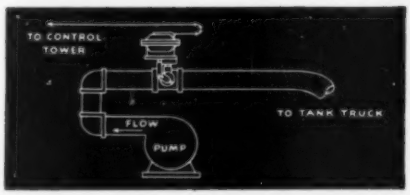
• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •

POWER OPERATED CONTROL OF DOWNSTREAM PRESSURE



A common application of R-S Valves is the power operated control and shut-off of downstream pressure or temperature. In the above diagrammatic drawing, the pressure or temperature controller (upper right) is actuated by the downstream pressure or temperature, and controls in turn the positioner and diaphragm top of the valve. Any liquid, gas or semi-solid can be controlled in this manner.

Accurate Measurement of Volume

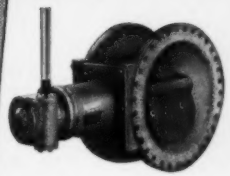


The accurate measurement of oil, gasoline, chemicals, etc. pumped from storage tank to tank truck or other container is a simple matter when arranged as illustrated. The pump is started and the R-S Valve opened at the same time from the control tower. A flow meter automatically shuts off the pump and valve when a predetermined number of gallons has been reached.

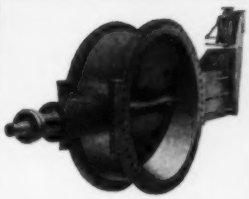
The angular discs of R-S Valves seat at an angle of 12½° to provide wedge-type metal to metal closure. These valves are rubber lined, rubber spool or rubber disc seated to provide positive 100% shut off.

For simplified control and shut off of volume and pressure, consult with your local R-S representative. You will find the address and phone number listed under "R-S Products Corporation, Valves."

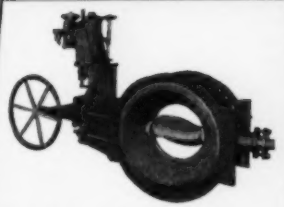
R-S Products Corporation, Wayne Junction, Philadelphia 44, Pa.



No. 732. 30-inch 50-pound Heavy Service Valve. Equipped with rubber spool, gear reduction drive and extended shaft. Limitorque Motor mounted above valve.



No. 735. 72-inch 125-pound "H" Metal Valve for elevated temperatures. Equipped with cooling fins, oil cylinder and positioner utilizing 200 psig oil and 0-15 psig instrument air.



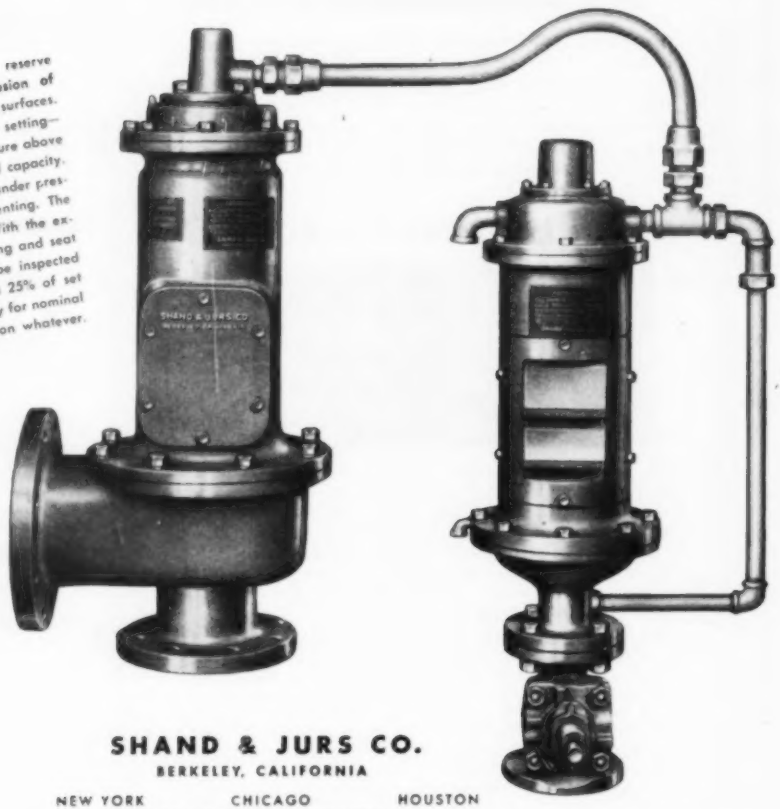
No. 742. 30-inch 150-pound Class B Steel Valve with air cylinder, cam driven positioner, hand wheel and declutching mechanism. Handles highly abrasive catalyst. Downstream cone replaceable.

No. 718. 18-inch straight Through Slide Valve. 150-pound American Standard raised face flanges. Air cylinder operated. Rising stem handwheel operator with declutching unit. Suitable for handling liquids, gases and semi-solids including catalysts.

PREVENTS *Rupture* OF PRESSURE TANKS

As storage pressures increase, property damage and personnel hazards also increase, and extra care is warranted in assuring that high pressure tanks are not ruptured by excessive internal pressures. To provide a positive method of protecting tankage against overpressure, we present our patented Pilot Operated Safety Valve, Model ST-2500, which incorporates numerous features not found in any other safety relief valve. This valve is available in 2", 4" and 6" sizes and is applicable to tanks operating at pressures above 10 pounds.

This valve incorporates a great reserve force for breaking ice or adhesion of gummy substances on the seating surfaces. It operates at the exact pressure setting—there is no accumulation of pressure above the set pressure required for full capacity. The main valve pallet is seated under pressure to the very instant of venting. The blowdown is at a minimum. With the exception of the main valve spring and seat proper, the entire valve can be inspected with a loss of not more than 25% of set pressure. It has a high capacity for nominal size and requires no lubrication whatever.



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Aerolube® 70

Cyanamid's New All-Chemical Motor Oil Additive

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When Performance Counts
... Call on Cyanamid

Write for information on AEROLUBE 70.

AMERICAN Cyanamid COMPANY
PETROLEUM CHEMICALS DEPARTMENT, DIV. A
30 Rockefeller Plaza, New York 20, N. Y.

"VALVE MEN" LIKE R-P&C VALVES

Men who really know valves—know where to look for those details of design and construction that insure top performance—have a lot of respect for Reading-Pratt & Cady.

An R-P & C valve must be more than just an assembly of machined parts. It has work to do. R-P & C feels the responsibility for that work being done faithfully.

Consider your R-P & C distributor as your "valve man"—a responsible source for bronze, iron and steel gate, globe, angle and check valves—Bar Stock valves—iron cocks—Lubrotite gate valves—cast steel fittings.

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TRADE MARK

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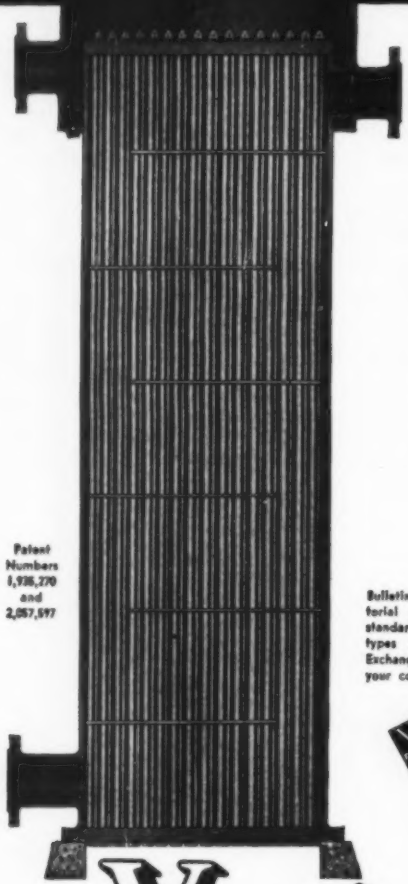
FILM TYPE EXCHANGERS

DETAIL SHOWING DISTRIBUTING FERRULE IN TUBE (Patent Pending)



Patent Numbers 1,935,270 and 2,057,597

Vogt engineers have taken a familiar refrigeration plant "old timer" and developed it into this modern, efficient heat exchanger.

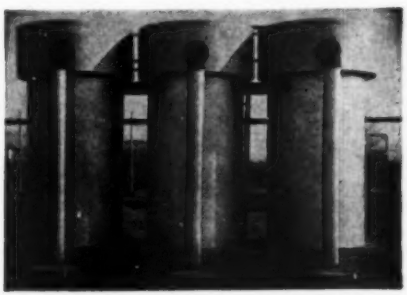
The film type exchanger operates in a vertical position. Water introduced in the top chamber is distributed in a thin film against the inner tube walls by means of special ferrules. The shell side of the exchanger has baffles arranged to provide optimum velocities, pressure drops, and heat transfer rates. Shutdowns are eliminated because tubes can be cleaned while the unit is in operation; thus permitting the use of dirty, mud and silt depositing water.

Vogt Film Type Exchangers now serve as Jacket Water Coolers, Sulphuric Acid Coolers, and Sulphur Dioxide Condensers, and can be designed to condense any vapor. They are also applicable for handling liquids other than water in film flow.

HENRY VOGT MACHINE CO., INC.
LOUISVILLE 10, KENTUCKY

Branch Offices: New York, Philadelphia, Cleveland, Chicago, St. Louis, Dallas

Bulletin HE-5 is a pictorial presentation of standard and special types of Vogt Heat Exchangers. Write for your copy.



Jacket Water Coolers serving engines of 7,300 H.P. Muddy well water used as cooling medium.

Vogt

HEAT TRANSFER EQUIPMENT

Refractories are applied to the steel panels at the job-site. Only simple formwork is required in lining the panels with castables.

Erection is simplified by installation of pre-fabricated panels.

This type of installation represents only one of the numerous uses of lightweight castable refractories in the petroleum refinery industry. For the application of lightweight castables in your plant, consult the Engineering Department of the A. P. Green Fire Brick Company.

Increase the Efficiency and Performance of Oil Heaters and Oil Stills with A. P. Green Lightweight Castable Refractories

A. P. Green Castable Refractories applied to Panel Casing Construction in new or old oil heaters and stills, offers you these 6 advantages:

1. Use of lightweight castable refractory materials developed for high operating temperatures.
2. Securely anchored lining—gives long, trouble-free service.
3. Increases the performance and efficiency of the furnace. With fewer joints air infiltration is reduced to a minimum.
4. Simplified construction—reduces erection time.
5. Lowers maintenance costs. Any tube section may be repaired by removing a series of the panels without disturbing the balance of the furnace arrangement.
6. Lower foundation costs due to the use of lightweight materials.

The A. P. Green Fire Brick Company Engineering Department will assist you with further information on the application of these materials to new units or the conversion of existing furnaces. Call your local A. P. Green distributor—he's listed in the yellow pages of your telephone directory—or write . . .

A. P. Green REFRACTORY PRODUCTS

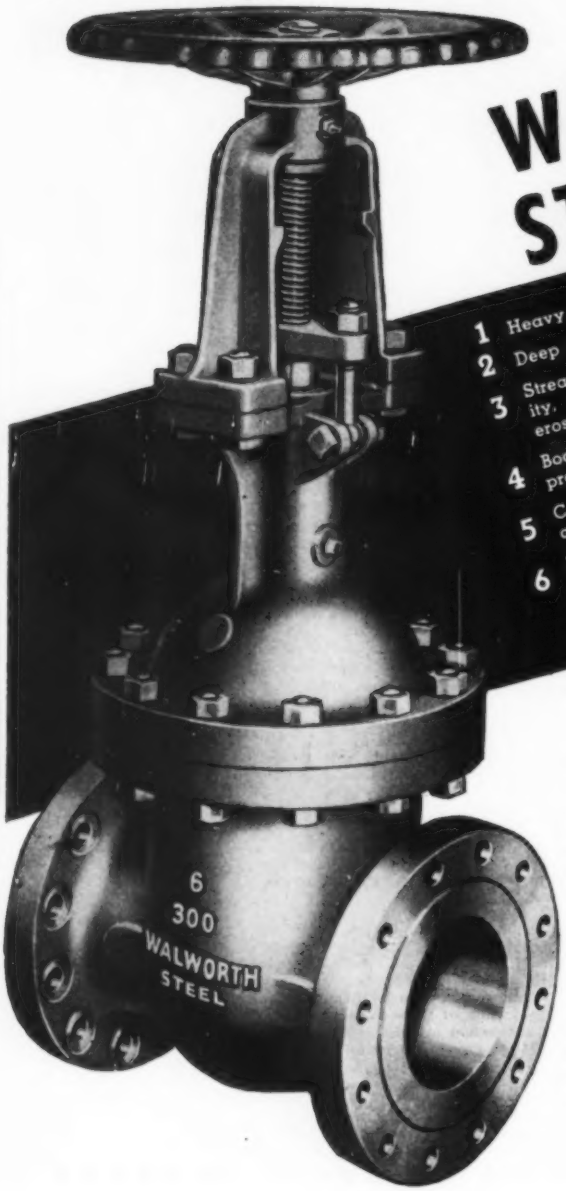
A. P. GREEN FIRE BRICK COMPANY

Mexico, Missouri, U. S. A.

A. P. Green Fire Brick Co., Ltd. in Canada

Representatives in the Principal Cities of the World

You get all these BIG features in WALWORTH STEEL VALVES



1. Heavy steel walls for extra strength and protection.
2. Deep stuffing boxes to eliminate costly leaks.
3. Streamlined ports to make possible a high velocity, non-turbulent flow, and reduces possible erosion.
4. Bodies and bonnets engineered to withstand pressure and minimize distortion.
5. Cast body guide rib faces, machined to insure accurate disc centering.
6. Exact design, metallurgy and construction of yoke nuts, bonnet bushings, gland followers, handwheels and other vital parts to assure better service for a longer period of time.

Is there any wonder that out in the field, where approval is based on performance under actual operating conditions, industry has put its O.K. on Walworth Steel Valves?

Tough . . . wear resistant . . . dependable, these valves are produced in gate and globe types, in sizes to cover practically every service requirement. They are excellent examples of Walworth leadership . . . leadership that has made the Walworth valves famous throughout the world.

Walworth Catalog 47 gives complete information regarding Steel Valves as well as the full line of Walworth valves and fittings in bronze and iron. Your copy may be obtained upon request. Whenever you need valves — whether steel, bronze or iron — remember Walworth for dependability, economy, and long service life.

WALWORTH
valves and fittings
60 EAST 42nd ST., NEW YORK 17, N. Y.

N.B. While it is axiomatic that return on investment—the *ultimate earning power* of a refinery unit when actually on stream—is the only true evaluation of competitive engineering recommendations, initial plant costs remain a major factor in refiners' decisions on plant installations. M. W. Kellogg takes specific steps to *minimize initial plant costs* consistent with the achievement of *highest ultimate earning power*.

HOW A GIANT BENDER LOWERS "CAT" COSTS

In today's huge *Fluid* cat-crackers, catalyst lines are a transportation system for the equivalent of some 600 freight cars of material every 24 hour period. Fabrication of pipe big enough to handle this job (up to 60 inches in diameter) has always been time-consuming and expensive.

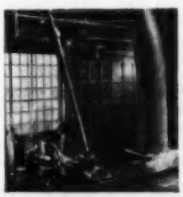
First, the curved pipe has always been tediously formed by welding together several, carefully-mitered sections. And then, the resulting irregular contour required the field-installation of wear plates to absorb erosion during on-stream periods.

To accomplish fabrication economies in this important part of the modern "cat", Kellogg's mechanical and metallurgical specialists produced something that had never been made before. They made *continuous one-piece* bends—in diameters up to 96 inches—by creating an *exclusive pipe-bending machine*.

All latitudinal welding, all special mitering is eliminated. In addition, because the insides of these new bends are smooth and in a continuous arc, wear plates are unnecessary . . . reducing field labor on just this one refinery part *by more than 50%*.

Thus the giant bender brings *initial savings* in addition to long-term protection . . . providing improved operating characteristics, radically lower maintenance costs and a reduction in down-time during turn-arounds.

This accomplishment could result only from pooling the talents and knowledge of an *integrated* organization, such as Kellogg, which includes fully-staffed groups versed in all phases of refining engineering, equipment fabrication and plant construction. Savings shown in this case history reflect only a small part of the overall opportunity for lowering costs, but they do emphasize that *completeness and integration* of the engineer-contractor are the soundest approach to LOW INITIAL PLANT COSTS.



THE M. W. KELLOGG COMPANY
A SUBSIDIARY OF PULLMAN, INC.
ENGINEERS TO THE PETROLEUM INDUSTRY
NEW YORK JERSEY CITY LOS ANGELES TULSA HOUSTON TORONTO LONDON PARIS

ALWAYS NEW FRONTIERS *for* POWELL

When the Oklahoma Territory was opened at 12 noon on April 22, 1889, more than 20,000 people were lined up on the border. At a signal by U.S. Cavalry, a remarkable race for homesteads ensued.

The amazing development of the United States has been a result of continually opening new frontiers—not only geographical, but scientific and industrial as well. In the latter sphere, The Wm. Powell Company has a long and proud record of settling the flow control requirements of each new industrial frontier as it has appeared—including such achievements as inventing the first regrinding globe valve, pioneering in the field of corrosion resistance, meeting the need for specially designed valves for special services, and many others.

As a result of this continual pioneering, *only* Powell makes such a complete line* that no matter what your flow control requirements may be, Powell has the valves to meet them. Moreover, Powell Engineers are always ready to help you solve any problems that might arise.

Fig. 1793 — Large 125-pound Iron Body Bronze Mounted Gate Valve with outside screw rising stem, bolted flanged yoke, tapered solid wedge.

Fig. 3061—Class 300-pound Cast Steel Swing Check Valve. Flanged ends and bolted flanged cap.

Fig. 102—200-pound Bronze Globe Valve with screwed ends, union bonnet and regrindable, renewable wear-resisting "Powellium" nickel-bronze seat and disc.

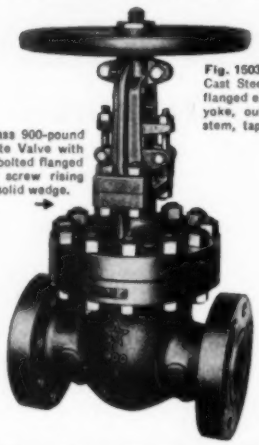


Fig. 9003—Class 900-pound Cast Steel Gate Valve with flanged ends, bolted flanged yoke, outside screw rising stem, tapered solid wedge.

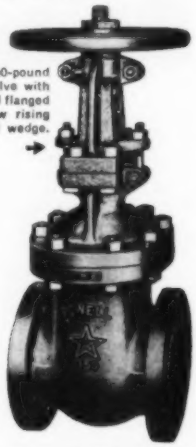


Fig. 1503—Class 150-pound Cast Steel Gate Valve with flanged ends, bolted flanged yoke, outside screw rising stem, tapered solid wedge.

*** Powell Valves are made in Bronze, Iron, Steel and a wide selection of Corrosion-Resistant metals and alloys. Valves of every type—Globe, Angle, Gate, Check, Non-return and Flush Bottom Tank Valves—are included in the Complete Powell Line.**

The Wm. Powell Company, Cincinnati 22, Ohio

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Armour & Co.
The Blanton Company
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General Mills, Inc.
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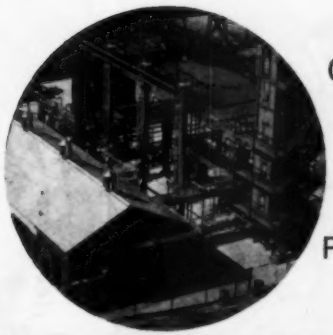
Lever Bros. Co.
Lookout Oil & Refining Co.
Procter & Gamble Co.
Procter & Gamble Mfg. Co.
Southern Cotton Oil Co.
South Texas Cotton Oil Co.
Mrs. Tucker's Foods, Inc.
Wilson & Co.



HYDROGEN PLANTS, FOR INSTANCE

Judge our qualifications by the company we keep!

Works speak louder than words, especially when we're talking gas processes and our ability to serve you well in that field. And probably the most convincing evidence of our qualifications is in the customers for whom we have done work.

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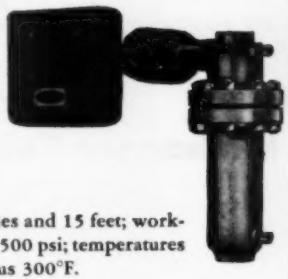
For all usual liquid level control, measurement and signaling applications, including interface service.



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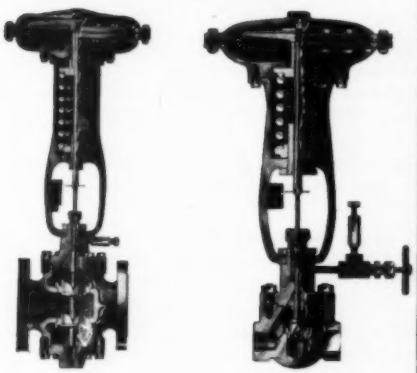

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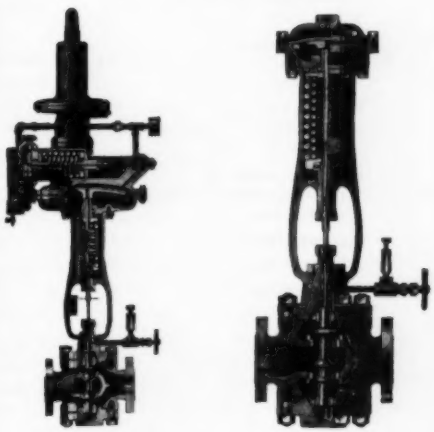

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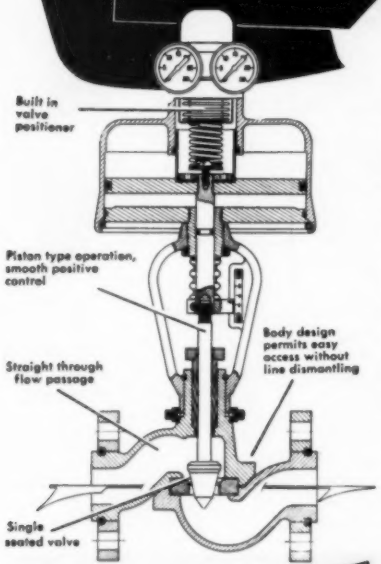
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Straight through flow passage
Body design permits easy access without line dismantling
Single seated valve

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Whether you burn oil, gas or a combination of these fuels, there's a NATIONAL AIROIL BURNER for your job.

Our more than 37 years' experience in the design, development and manufacture of all types of industrial burners is at your service.

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OIL BURNERS and **GAS BURNERS** for industrial power, process and heating purposes; **STEAM ATOMIZING OIL BURNERS; MOTOR-DRIVEN ROTARY OIL BURNERS; MECHANICAL PRESSURE ATOMIZING OIL BURNERS; LOW AIR PRESSURE OIL BURNERS; GAS BURNERS; COMBINATION GAS and OIL BURNERS; AUTOMATIC OIL BURNERS,** for small process furnaces and heating plants; **FUEL OIL HEATERS; FUEL OIL PUMPING and HEATING UNITS; FURNACE RELIEF DOORS; AIR INTAKE DOORS; OBSERVATION PORTS; SPECIAL REFRACTORY SHAPES.**

TYPE "S-A"

Uses steam or compressed air for atomization. Thoroughly atomizes and completely burns the lowest and cheapest grades of fuel oil and tars. Requires only low oil pressure and temperature.

TYPE "S-A-L"

Large capacity burner of steam atomizing type. Adaptable to large boilers or dual fuel systems. Is frequently used for firing boilers above existing coal grates.

TYPE "S-A-R"

(Where steam, or gas is available for atomizing) safely and efficiently burns residuums obtained from process.

COMBINATION GAS AND OIL BURNERS

An "Airocool" Gas Burner in combination with a Type "S-A-R" Steam Atomizing Oil Burner. Type "S-A-R" safely and efficiently burns residuums obtained from process.

"AIROCOOL" GAS BURNER

Venturi type. Patented, long-life "Airocool" Nozzle assures trouble-free operation and provides low turn-down without burn-back.

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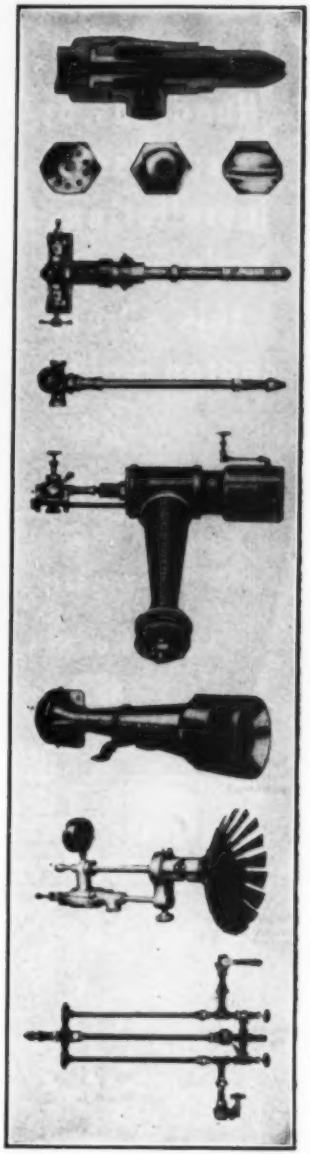
(Refuse Oil Burner) burns acids or caustic oils, sludges, asphalts, tank bottoms, polymer oils, heavy petrolatum, organic oil residuums, waste cutting oils, sulphite, pulp liquors in combination with fuel oil.



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All too frequently stress-concentrations have been the cause of stud failure in the high-temperature bolting jobs encountered in refineries. But with the Bethlehem continuous-thread stud shown here, failure is practically unheard of, regardless of high temperatures or high pressures.

The Bethlehem continuous-thread stud resists stress-concentrations because it has no point of thread run-out. Those stresses which do occur are effectively distributed over the entire length of the stud, thus enabling it to provide economical performance for long periods of time.

The Bethlehem continuous-thread stud is made from carbon or alloy steels, and comes either plain or heat-treated. It is furnished in a complete range of diameters and in any length, with most sizes carried in stock.

Bethlehem also manufactures the continuous-thread tap-end stud for installations requiring but one nut. This stud has its chamfered tap-end threaded to Class 5 fit, and its rounded nut-end threaded to either Class 2, 3 or 7 fit, yet the blending of threads is accomplished so skillfully that the point of change is undetectable.

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CONTINUOUS-THREAD STUDS ARE A PRODUCT OF BETHLEHEM'S LEBANON, PA., PLANT

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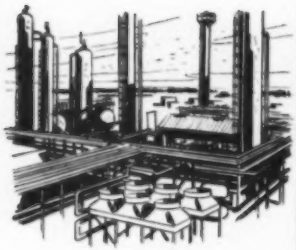
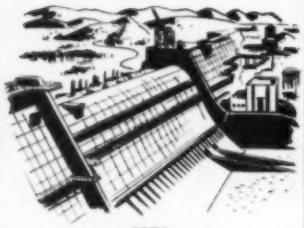
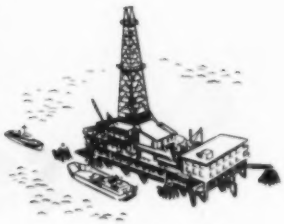


GASOLINE PLANTS



DAMS



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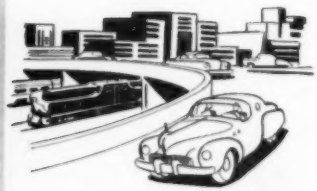
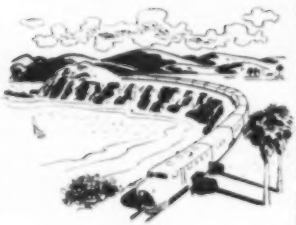
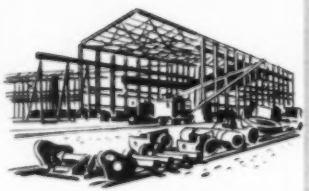


HIGHWAYS



RAILROADS



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PETROLEUM
REFINER

VOLUME 28, NO. 7 JULY, 1949

The LOOK BOX

PROCESS engineers of necessity are specialists. The complexities of their work require rather special abilities, training, and experience. Even so, specialization sometimes seems to reach unnecessary and undesirable extremes.

Bridging An Industry Gap

The rough division of process plant designers and operators into "gas men" and "heavy oil men" is a case in point.

This division rests mainly on the methods of calculation generally used for gases and light hydrocarbons through the gasoline boiling range as contrasted with calculation methods for the heavier oils.

The "gas men" work with the equilibrium vaporization constants of individual hydrocarbons in algebraic type equations to obtain rather precise answers—after a tremendous amount of detailed calculation. The "heavy oil men" work with flash curves that give rather rough answers in terms of the boiling ranges of the process streams—after perhaps much less detailed calculation. Each method has its advantages and its limitations. The algebraic method using individual components is impractical with the heavy oils because of the great number of components. Too, the available equilibrium data are not extensive, and the analysis of heavy oils for their individual components is a monumental task. Flash curve methods do not work well with light gas mixtures involving few components. A considerable number of components are required to give smooth curves.

Towers making separations of naphthas and solvents in the gasoline boiling range are designed by either method, the choice ordinarily depending upon the preferences and prejudices of the individual designer.

In the past, an engineer concerned with natural gasoline processing was a "gas man" and one dealing with refinery processes was a "heavy oil man." This is no longer the case. Gasoline plants now process distillates of kerosine and heavier boiling range. Crude oil production is increasingly routed directly into them for initial casinghead separation and crude oil stabilization. Refiners are more and more concerned with gas fractionation and light hydrocarbon conversion processes. A thoroughly competent processman in either field must now know how to handle the whole range of petroleum fractions from methane to tar. Probably this is all to the good. The basic process equipment—fractionators, pumps, compressors, heat exchangers, heaters, cooling towers, instruments, and so on—are identical in principle and for the most part identical in physical construction. The division is arbitrary and is rapidly becoming of little significance.

The article, "Equilibrium Constants for High-Boiling Hydrocarbon Fractions of Varying Characterization Factors," on page 101 of this issue is in keeping with the trend. This development of new design procedures is typical of the changes occurring in our industry that tend to bridge whatever gap still exists between process plants having gas feed and those having liquid feed. It applies methods which for the most part have been developed in the natural gasoline plants to solve problems that are primarily of interest to refiners.

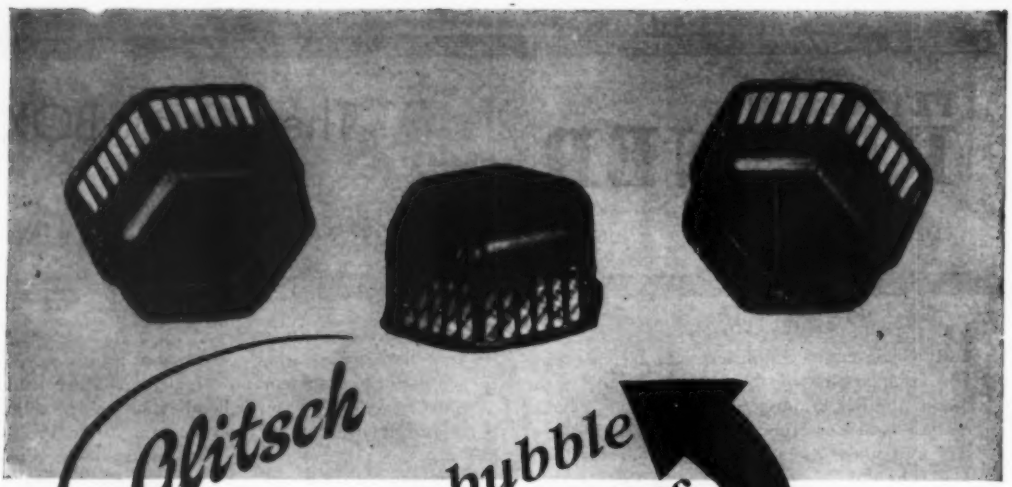
Safety With Safe Practices

APPLICATION of sound safety practices has brought about a status in the oil and gas industry which has been succinctly put thus: "Neither gas nor oil is dangerous when properly handled" and "where there's petroleum, there's progress with safety."

These are the statements of Frank G. Wilson, director of safety, American Petroleum Institute, who in a recent address cited the petroleum industry's records of safety and fire prevention to prove his point.

"When properly handled, gasoline and oil are safe liquids to work with," he said. "Fires, like accidents, just don't happen, they are caused. Neither gasoline nor oil will ignite of itself so when you read of some gasoline or oil fire, don't jump to a conclusion before you know the facts surrounding the incident. . . ."

Wilson urged his listeners to "please remember that the fire might have been avoided by observ-



Glitsch draws hex bubble caps in stainless alloy

New Fabrication Method Developed To Produce Hexagonal Bubble Caps of Drawn One-Piece Construction.

These Caps Are Lightweight, Sturdy and Corrosion-Resistant.

Illustrated are three of one order of 13,000 hex bubble caps each drawn of one piece of 12% chrome. These caps will be used on a group of 20 GLITSCH "Truss-Type" bubble trays, each one 24'-0" in diameter.

Caps of any shape, size and of any analysis of material (including Hastelloy) can be fabricated or drawn in our plant. Certain shapes are more economical to draw, other shapes to fabricate. Equipped with tools and dies for fabricating or drawing practically every size and shape of bubble cap from 2" to 9" diameter, with a large selection of shapes and sizes of cap slots, we invite your inquiry. Send your prints for quotations.

1. **Lightweight and easy to handle.**
2. **Obtainable in any alloy to meet your corrosion problem.**
3. **Easy to clean, and not subject to breakage like cast materials.**
4. **Economical — and pay for themselves in lessened maintenance costs.**
5. **The answer to process engineers in their designing of caps for maximum efficiency and minimum pressure drop.**

MANUFACTURED UNDER U. S. PATENT NO. RE 22946; NO. 2,341,091; NO. 2,309,309; NO. 2,338,928; NO. 2,375,409; NO. 2,420,075; NO. 2,422,300; NO. 2,461,729 AND OTHER PATENTS PENDING

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"TRUSS-TYPE" BUBBLE TRAYS ● BUBBLE CAPS ● TOWER INTERNALS

ance of established and well-known recommendations of the API and the National Fire Protection Association."

The API safety director noted that petroleum industry employes work in an atmosphere of "planned accident and fire prevention." He called attention to the fact that the API itself issues a special award to petroleum companies attaining a million man-hours of accident free operation.

Wilson said that frequently "erroneous and misleading comparisons" create false and mistaken impressions of hazards incident to the storage of gasoline. He also stated that "much of the misconceptions of the safety of petroleum products can be traced to distortions in the news."

Industry Trends Called Favorable

ECONOMIC trends in the oil industry during June were the most favorable of the year. Highly encouraging was the stoppage of additions to crude oil stocks during the month and the prospect that sizable decreases in such stocks may occur in July and August. Less favorable developments that partially discount the encouraging ones center around the fuel oil situation.

Lower production allowables have been set in Texas, Louisiana, and Arkansas for the month of July. It is indicated that United States production will average around 4,800,000 barrels daily in July as compared with 4,930,000 in June. Since June crude rates were closely in balance with requirements, reduced production in July should cause withdrawals from stored crude stocks. Predictions of the amount range 4 to 10 million barrels. Unless the Texas Railroad Commission issues a revised order upping the state's allowable in August (the commission has issued a two-month order for July and August cutting allowables by 125,000 barrels daily) another 6 to 10 million barrels likely will be taken from storage during August.

The crude oil market reflects an increased stability. Some further price reductions occurred in the first half of June but none was made in the latter part of the month. Pennsylvania Grade crude prices advanced 13 to 16 cents per barrel after having experienced six successive reductions since last December. Increases up to 28 cents per barrel were posted for lighter California crudes, although reductions up to 22 cents were made at the same time for heavy grade crudes. It is anticipated that the reduction in crude production will cause some shortages of light crude oils, that much of the oil to be withdrawn from storage will be in the lighter ranges.

Gasoline stock drafts continue to take place in such volume that earlier worries of an oversupply are disappearing rapidly. A continuation of the present withdrawal rate will bring gasoline inventories down to about 75 or 80 million barrels on October 1, the end of the big consuming season. This would be well under the 90½ million barrels in storage on October 1 last year and also beneath the figure of 85 million barrels generally accepted as a desirable level for this time of the year.

Prospects for light heating oil sales are showing improvements. Shipments of new oil burners are substantially exceeding those of last year. It is estimated that sales of heating oils may run as much as 8 percent higher this winter than last winter.

The situation with residual and heavy distillate fuel oils is much less favorable. The growth in distillate and residual fuel oil stocks and their high level for this season of the year may cause a serious oversupply next winter. Three reasons underlie apprehension on this score: 1) the continued importation of foreign-produced crude at higher rates than in the corresponding months of 1948, much of which yields large quantities of unneeded fuel oils; 2) improper application of restrictions on U. S. production which has resulted in an oversupply of fuel-oil-bearing crudes and a shortage of needed gasoline-yielding crudes; and 3) prospective increased refinery runs because of anticipated higher gasoline demand which would enlarge the production of fuel oils along with greater output of gasoline.

Although the outlook now is for the sale of more distillate fuel oil than heretofore anticipated, stocks of this product must still be regarded as excessive. Inventories of distillate fuel oils east of California now total 50 million barrels, an increase of 19 million barrels or 60 percent over a year ago. Therefore, refiners must continue to hold yields of these products to a minimum, particularly if crude runs to stills are increased. In view of this surplus of heavy oils the installation of additional facilities for handling them would seem imperative.

"We have made our progress only because we have been willing, individually and collectively, to invest more and more money in providing these tools of production. Since 1924 the investment in American industry has nearly doubled.

"But back of that willingness to save, to invest, to risk those savings in industrial ventures is the hope of profit. Remove that profit motive and we destroy all hope of future prosperity."—CRAWFORD H. GREENEWALT, *President, E. I. Du Pont de Nemours and Company.*

A Company is known by the stability it keeps....

The advertisement on the facing page marks an historic milestone for this publication and for a company whose name is familiar to all Petroleum Refiner readers throughout the world.

Twenty-five years ago this month the present Lagonda Division of Elliott Company carried their initial advertisement in Petroleum Refiner—then known as Refiner and Natural Gasoline Manufacturer.

Few persons in the refining business a quarter century ago visualized the magnitude, the remarkable technical developments and the worldwide scope of the petroleum refining industry as it exists today. The growth and technical achievements of this industry have set the pace for a mechanized world and month after month during those twenty-five years, Elliott Company advertisements have kept refinery men informed of the equipment with which Elliott serves this industry.

This month marks the 300th consecutive issue of Petroleum Refiner in which Elliott Company has carried one or more advertisements.

We salute a truly stable advertiser!

PETROLEUM
REFINER

SPECIALIZED FOR REFINING, NATURAL GASOLINE AND PETROCHEMICAL ENGINEERING, OPERATION AND MANAGEMENT

TRUE 25 YEARS AGO
DOUBLY TRUE TODAY

JULY, 1924

Cleaning tubes in oil still, Wichita, Kansas

In the cleaning of still tubes, experience counts!

From "The Refiner and Natural Gasoline Manufacturer," July, 1924. The first LAGONDA ad of a twenty-five year series without a single holiday.

LAGONDA Cleaners have been used for twenty-five years in the cleaning of all kinds of scale accumulation from the tubes of boilers and other apparatus. We have worked with the manufacturers of pressure tube stills since their first employment for this work.

The cleaning of the hard coke deposit in pressure still tubes has required the development of more or less specialized cleaners and cutting heads. We are prepared to furnish the exact type of equipment necessary. When you find Lagonda Cleaners specified or furnished as part of the still equip-
may be sure that they have

This first LAGONDA CLEANER ADVERTISEMENT had it right

It's *fifty* years of experience now—a full half century of learning how to design tube cleaner motors that will speed up the job . . . armed with cutter heads developed to the ultimate through those fifty tough years of grueling service in cleaning refinery still tubes.

The LAGONDA Cleaner of today cuts down-time with all the coke-smashing toughness that fifty invaluable years of "know-how" can give it. Try LAGONDA on your meanest tube cleaning job.

Y-288

Lagonda
STILL TUBE CLEANERS

ELLIOTT COMPANY
Lagonda Division
SPRINGFIELD, OHIO
Plants in JEANNETTE, PA. • RIDGWAY, PA.
SPRINGFIELD, O. • NEWARK, N. J.
DISTRICT OFFICES IN PRINCIPAL CITIES

REFINERY and Other PLANT CONSTRUCTION

Petroleum Refiner's exclusive feature which, in boxscore form, presents a quick picture of the tremendous amount of plant construction work that is in progress or projected by oil and other companies in all sections of the world.

The tabulation presented each month under the heading "Refinery and Other Plant Construction" represents a continuing check of the building program that is in progress in the refining, natural gasoline and petrochemical industry. Since August, 1947, it has appeared as an exclusive feature in PETROLEUM REFINER and it has proved a valuable aid and guide to our readers.

Companies whose projects are not listed or readers who know of projects not listed are urged to: 1) send in data on such units as called for by unit headings; 2) furnish details which are missing in any item in the current tabulation, and 3) report from time to time on the progress of these projects. Address, Editor, PETROLEUM REFINER, Box 2608, Houston 1, Texas. Cooperation together with suggestions are very much appreciated.

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EAST									
E. I. DuPont	Parkersburg, W. Va.	Tetrafluoroethylene Resin Plant			Under Constr.	Summer, 1950			
Esso Standard Oil	Linden, N.J.	Vac. pipe still	40,000 bbls.		Under Constr.	2nd Qtr., 1949		S.O.D. & Braun	Braun
Esso Standard Oil	Linden, N.J.	Cat. Crack, Light Ends	41,000 bbls.		Under Constr.	3rd Qtr., 1949		S.O.D., Braun	Braun
Esso Standard Oil	Bayonne, N.J.	Dewaxing	7,500 bbls.		Under Constr.	1st Qtr., 1950	Texaco	Badger	Badger
Esso Standard Oil Co.	Linden, N.J.	Steam Boiler	200,000 lbs. hr.		Under Constr.	2nd Qtr., 1949		S. O. D.	
Esso Standard Oil Co.	Bayonne, N.J.	Steam Boilers	400,000 lbs. hr.		Under Constr.	2nd Qtr., 1950		S. O. D., Day & Zimmermann	S. O. D., Day & Zimmermann
Freeport Sulphur Co.	Westville, N.J.	Sulfur Recovery Plant	40 tons		Contracted				Girdler
Gulf Oil Corp.	Philadelphia, Pa.	Topping and Vacuum Unit	30,000 bbls.		Under Constr.	Nov., 1949		Lummus, Badger	Lummus
*Pure Oil Co.	Savannah, Ga.	Lube Blending & Packaging Plant			Under Constr.	Nov. 1, 1949			
Socony-Vacuum Oil Co., Inc.	Paulsboro, N.J.	Crude, Dist. Unit	10,800 bbls.		Under Constr.	Mid 1949		Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	Propane Deasphalting	5,950 bbls.		Under Constr	Mid 1949	Juik	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	Furfural Refg.	4,450 bbls.			Completed	Texaco	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	MEK Dewaxing	2,050 bbls.		Under Constr.	Mid 1949	Texaco	Badger	Badger
Socony-Vacuum Oil Co., Inc.	Paulsboro, N.J.	Light Oil Treating Plant	28,000 bbls.		Designing	Late 1949		Badger	Badger
L. Sonnebern Sons, Inc.	Petrolia, Pa.	Enlarge Anti-Pollution		$400,000	Under Constr.	Mid 1949		Chemical Constr. Co.	Morris Knowles & Co.
Sun Oil Co.	MarcusHook, Pa.	Wax			Under Constr.	July, 1949	Texaco	Staff	Staff
Sun Oil Co.	Marcus Hook	Comp. & Pkg.			Under Constr.	August, 1949		Staff, Lindsay	W. W. Lindsay
The Texas Co.	Beacon, N.Y.	Expand Research Labs.			Under Constr.	Dec. 1, 1949		Voorhees, Walker, Foley & Smith	
The Texas Co.	Westville, N.J.	New Refinery	40,000 bbls.		Under Constr.			Foster-Wheeler, Jackson-Moreland, Kellogg	Foster-Wheeler, Kellogg
U.S. Dept. of Interior	Bruceton, Pa.	Fischer-Tropsch Pilot Plant (Coal-to-gasoline synthesis)	1-2 bbls.	$150,000	Under Constr.	Nov., 1949		Staff	Blaw-Knox Co.
MID-CONTINENT									
Ashland Oil & Refining Co.	Canton, Ohio	Ref. Modernization			Under Constr.	Middle 1949			Cat. Constr.
The Carter Oil Co.	McKamie, Ark.	Pressure Maintenance Unit Expansion	38,000 mcf		Under Constr. Designing	July, 1949 1950		J. & L. Constr.	J. & L. Cons
Champlin Refining Co.	Enid, Oklahoma	Crude Unit	18,000 bbls.	$600,000	Under Constr.	Fall, 1949		Koch	Staff
Champlin Refining Co.	Enid, Oklahoma	Cat Poly Unit	450 bbls.	$200,000	Under Constr.	Fall, 1949	U.O.P.	Koch	Staff
Cities Service Oil Co.	Chicago, Ill	Compounding & Grease Plant	1,200 bbls.	$4 million	Under Constr.	Late 1949		Sumner-Sollitt	Sumner-Sollitt
Cooperative Refinery Association	Coffeyville, Kansas	Dewaxing	2,200 bbls.	$1.5 million	Contracted	3rd Quarter, 1949	Texaco	Process Eng.	Process Eng.
Continental Oil Co.	Ponca City Oklahoma	Crude Dist. Unit	30,000 bbls.		Under Constr.	Oct., 1949		Bechtel	Bechtel
*Deep Rock Oil Corp	Cushing, Okla.	Cat. Cracker Plant	5,000 bbls.		Under Constr.	Spring 1950		J. & L. Constr.	J. & L. Constr.
Dewese Oil Co.	Weston, Ohio	Lube Filtering Unit	250 bbls.	$15,000	Under Constr.	Summer, 1949		Staff	Staff
The Globe Oil & Refining Co.	Lemont, Ill.	Cat. Cracker Unit	6,000 bbls.	$1 million	Buying Material	Jan. 1, 1950	U.O.P.	U.O.P.	
Gulf Oil Corp.	Kiefer, Okla.	Expand Gasoline Plant	14,500 mcf		Under Constr.				
Gulf Refg. Co.	Toledo, Ohio	Fluid Cat. Crk.	15,500 bbls.		Under Constr.	Sept., 1949		Kellogg	Kellogg
Gulf Refg. Co.	Toledo, Ohio	Poly Unit	5,000 bbls.		Under Constr.	Aug., 1949	U.O.P.	Kellogg	Kellogg
Gulf Refg. Co.	Cincinnati, Ohio	Fluid Cat Cracker Unit	15,500 bbls.		Under Constr.	Oct., 1949		Kellogg	Kellogg
Gulf Refg. Co.	Cincinnati, Ohio	Poly Unit	5,000 bbls.		Under Constr.	Sept., 1949	U.O.P.	Kellogg	Kellogg

REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

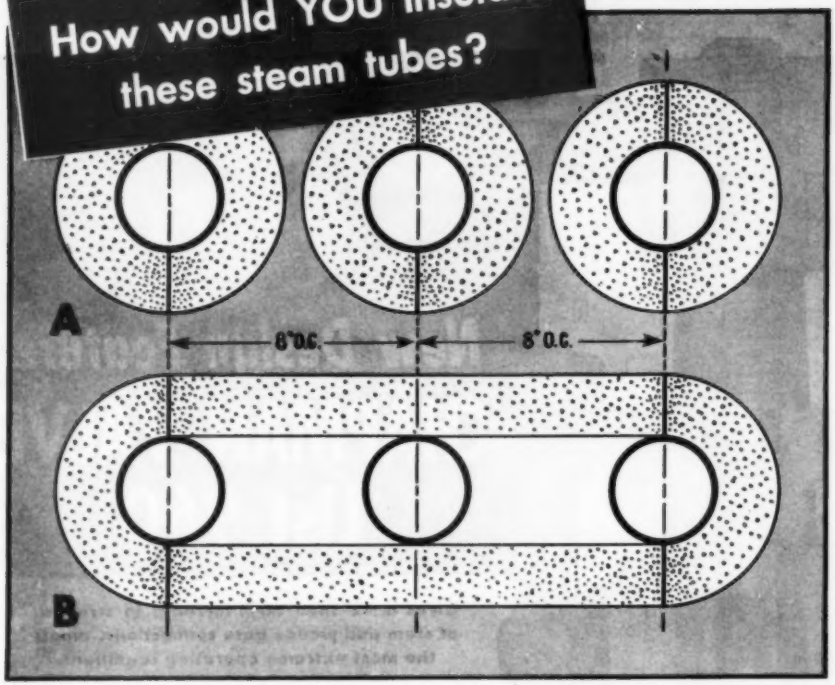
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*Lion Oil Co.	El Dorado, Ark.	Ammonium Nitrate Prilling Plant	400 tons	$1,200,000 min	Under Constr.	Aug., 1949	Canadian Gov't.	Chem. Constr.	Blaw-Knox
Lion Oil Co.	El Dorado, Ark.	Sulfuric Acid Plant	300 tons	$1½ million	Under Constr.	Sept., 1949		Chem. Constr.	Chem. Constr.
Lion Oil Co.	El Dorado, Ark.	Ammonium Sulfate Plant	380 tons	$750,000	Under Constr.	Sept., 1949		Chem. Constr.	Chem. Constr., Blaw-Knox
M. F. A. Oil Co.	Chanute, Kans.	Desulfurization	1,000 bbls.	$75,000	Under Constr.	Sept., 1949	Phillips	Koch	Staff
Magnolia Pet. Co.	Grant County, Kans.,(Hickok)	Gasoline Plant	100,000 mcf		Under Constr.	Nov., 1949		Staff, Waleo	Waleo
Magnolia Pet. Co.	Chitwood, Oklahoma	Pressure Maintenance & Cycling	35,750 mcf		Under Constr.	Dec., 1949		Staff, Delta	Constr. Service
Magnolia Petroleum Co.	Stephens County, Okla.	Gasoline Plant	30,000 mcf		Under Constr.	March, 1950		Staff J. & L. Constr.	J. & L. Constr.
Midland Cooperative Wholesale	Cushing, Okla.	Cat. Poly Unit	200 bbls.		Authorized	Early 1950			Ref. Eng., U.O.P
*Northern Natural Gas Co.	Clifton, Kans.	Compressor Add.	1,600 hp.		Under Constr.	1949			Fluor
Ohio Oil Co.	Robinson, Ill.	Vac. Unit Cat. Crack, Crude Still, Poly, LP G Recovery	27,500 bbls.	$15 million	Under Constr.	Mid 1950	U.O.P.	McKee	McKee, Pritchard
*Oklahoma Refining Co.	3 Mi. S.E. Seminole, Okla.	Refinery	200 bbls.	$40,000		Oct. 1, 1949			
Peteo Corp.	Blue Island, Ill.	Houdriflow Cat. Cracker Unit, LPG Recovery System	5,000 bbls.	$400,000	Under Constr.	Last Quarter, 1949	Houdry	Houdry	Clarke
Petroleum Specialties, Inc.	Flatrock, Mich.	Additional Tankage		$85,000		Completed			
Phillips Pet. Co.	Kansas Cy, Kans.	Cat. Crack	24,000 bbls.	$10 million	Under Constr.	Nov., 1949		Braun	Braun
Phillips Pet. Co.	Guymon, Okla.	Cat. Poly	1,500 bbls.			Completed			Cat. Constr
The Pure Oil Co.	Toledo, Ohio	Absorption Plant	172,000 mcf		Under Constr.	1st Qtr., 1949			
Rock Island Refg. Corp.	Rock Island, Ind.	Revamping Crude Reforming Units							
The Shallow Water Refining Co.	Shallow Water, Kansas	Fluid Cat. Crk.	10,000 bbls.	$1,200,000	Under Constr.	July, 1949	U.O.P.	U.O.P.	Staff
Skelly Oil Co.	Eldorado, Kans.	Reforming Unit	1,250 bbls.	$85,000	Under Constr.	Fall, 1949	Perco	Koch Eng.	Koch Eng.
Socony-Vacuum	E. St. Louis, Ill.	Crude Dist. Unit, Cat. Crk.	35,000 bbls.	$8-10 million	Under Constr.	Mid 1950			
Socony-Vacuum Oil Co.	East St. Louis, Illinois	Crude Distillation	15,000 bbls.		Under Constr.	Aug., 1949		Staff	Bechtel
Socony-Vacuum Oil Co.	East St. Louis, Illinois	Thermal Cracking, Reforming, Visbreaker Unit	13,200 bbls		Under Constr.	Dec., 1949		Staff	Bechtel
Socony-Vacuum Oil Co.	East St. Louis, Illinois	Tannin Solutiser Treating Unit	18,000 bbls.			Completed		Staff, Bechtel	Bechtel
Socony-Vacuum Oil Co.	East St. Louis, Illinois	Miscl. Refinery Additions			Under Constr.	Sept., 1949		Staff	Bechtel
Socony-Vacuum Oil Co.	East St. Louis, Illinois	Delayed Coking Unit	8,000 bbls.		Under Constr.	Dec., 1949		Staff	Bechtel
Standard Oil Co., (Ohio)	Lima, Ohio	Furfural Refining Plant	76,000 gals.	$13 million	Contracted	1951	Texaco	Lummus	Lummus
Standard Oil Co., (Ohio)	Lima, Ohio	Cat. Cracking	16,000 bbls.	$11 million	Under Constr.	Late 1949	U.O.P.	McKee	McKee
Standard Oil Co., (Ohio)	Lima, Ohio	Crude Dstl., Coke	†15,000 bbls.	$5 million	Authorized	Mid 1950	Kellogg	Kellogg	Kellogg
Standard Oil Co., (Ohio)	Lima, Ohio	Solvent Dewaxing Unit	1,800 bbls. Finished Products		Authorized	Mid 1950	Texaco	Lummus	Lummus
Standard Oil Co., (Ohio)	Lima, Ohio	Vacuum Unit	9,000 bbls.		Authorized	Mid 1950			Lummus
Standard Oil Co., (Ohio)	Lima, Ohio	Propane Dephalting Unit	800 bbls.		Authorized	Mid 1950			Lummus
Sun Oil Co.	Toledo, Ohio	Cat. Crack, Crude Dist., Vac., Poly	30,000 bbls.	$16 million	Under Constr.	Jan., 1950	Houdry	Houdry, Cat. Constr., Process Eng., Staff	Cat. Constr.
*Sun Oil Co.	Toledo, Ohio	Compressor Station	1,840 hp.		Designing			Fluor	
The Texas Co.	W. Tulsa, Okla.	Expand. Modernize Refinery	30,000 bbls.		Under Constr.			Kellogg, Foster-Wheeler, U.O.P.	Kellogg, Foster Wheeler
The Texas Co.	Lawrenceville, Illinois	Expand Refinery	†20,000 bbls.		Design	April 1, 1951		Foster-Wheeler, Kellogg	Foster-Wheeler, Kellogg
Tide Water Associated Oil Co.	Drumwright, Oklahoma	Houdriflow Unit Cat. Cracker	4,500 bbls.		Contracted		Houdry		Process Eng.
U.S. Dept. of Interior	Louisiana, Mo.	Demonstration Oil-from-Coal Plant	80 bbls.	$5 million	Under Constr.	Dec., 1949		Koppers	Koppers
West Cement Medrano Unit	Caddo County, Oklahoma	Gas Injection Facility	9000 mcf	$1 million	Under Constr.	July, 1949		Dresser	Dresser
Wood River Oil & Refining Co., Inc.	Hartford, Ill.	Vacuum Unit	15,000 bbls.	$700,000	Under Constr.	August, 1949		Koch	Staff
Wood River Oil & Refining Co., Inc.	Hartford, Ill.	Fluid Cat. Cracker	7500 bbls.	$2.5 million	Under Constr.	Dec., 1949	U.O.P.	Koch	Staff
SOUTHWEST									
The California Co.	Brookhaven, Mississippi	Cycling Plant	10,000 mcf		Designing	3rd Qtr., 1949		Hudson	Hudson
Barnsdall Oil Co.	Placedo, Tex.	Compressor Station	2000 hp.	$380,000	Under Constr.	July, 1949		Olsen	Olsen
*Brazos River Gas Co.	Mineral Wells, Texas	Gasoline Plant	15,000 mcf		Under Constr.	Sept., 1949		R. L. Purvin & Richard Henry	
Calumet Ref. Co.	Princeton, La.	Blending Oil Tank House	700 bbls.		Under Constr.	3rd Qtr., 1949		Staff	Staff
Carthage Hydrocol, Inc.	Brownsville, Texas	Hydrocol	87,000 mcf	$26 million	Under Constr.	Dec., 1949	Hydro-Res., Inc.	McKee, Hydro-Res., Inc.	McKee
Cit-Con Corp.	Lake Charles, La.	Lube Plant	6,000 bbls.	$42 million	Under Constr.	Sept. 1, 1949	Texaco	Max B. Miller, Lummus	Lummus, Max B. Miller
Cities Service Oil Co. and Continental Oil Co.	Lake Charles, La.	Lube Plant					Texaco, Max B. Miller		
Cities Service Oil Co.	Pampa, Texas	Gasoline Plant	18,000 mcf		Contracted	1949		Waleo	Waleo
Cities Service Oil Co.	Chico Field, Wise Co., Tex.	Natural Gasoline Plant	22,000 mcf		Designing	Early, 1950		Fluor	Fluor
Cities Service Oil Company	St. Rose, La.	Lube Oil Blending	1500 bbls.	$750,000	Under Constr.	Late 1949		Day & Zimmerman	Day & Zimmerman
Claborne Gasoline Co.	Lisbon, La.	Enlarge Pipeline Absorption Plant	125,000 mcf		Under Constr.	August, 1949		Pet. Eng.	

REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*Continental Oil Co.	Starr County, Texas	Gasoline Plant Enlargement	20,000 mcf.	$1.5 million	Under Constr.	Dec., 1949			
Continental Oil Co.	Todd (Deep) Field, Texas	Gas Recovery Plant	10,000 mcf		Under Constr.	Sept., 1949		Ref. Maint.	Ref. Maint.
Cosden Pet. Corp.	Big Spring, Tex.	Fluid Cat. Plant	6,000 bbls.	$2 million	Under Constr.	Nov., 1949	U.O.P.	U.O.P.	Ref. Eng
Department of the Army	Houston, Tex.	Anhydrous Ammonia Facility	2100 tons monthly	$2.5 million	Relocating	Sept., 1949		Girdler Corp.	Hercules Powder Co.
*El Paso Natural Gas Co.	Mohans Field, Texas	Gasoline Plant	16,700 mcf.		Designing	1949		Fluor	Staff
*El Paso Natural Gas Co.	Mohans Field, Texas	Treating Plant			Designing	1949		Fluor	Staff
E. I. duPont de Nemours Co., Inc.	Victoria Tex.	Chemical Intermediates for Nylon			Design	Early 1951		Staff	Staff
Ethyl Corp.	Baton Rouge, La.	Mfg. Facilities		$40 million	Under Constr.	Oct., 1949		Stone & Webster	Stone & Webster
*Esso Standard Oil Co.	Baton Rouge, La.	Mechanical Shops				Completed		Braun	Braun
*B. F. Goodrich Co	Port Neches, Texas	Expand Plant		$800,000	Under Constr.			Staff	Carruth Constructing Co.
Gulf Oil Corp.	Crane, Texas	Gasoline Plant	40,000 mcf		Under Constr.	July, 1949		Braun	Braun, W. H. Bowden
Humble O&R Co.	Katy, Texas	Add Propane, Absorption, refrigeration	Unchanged		Under Constr.	Oct., 1949		Stearns-Roger	Stearns-Roger
Humble O&R Co.	Conroe, Texas	Absorption Facilities	30,000 mcf		Under Constr.	Oct., 1949		Stearns-Roger	Stearns-Roger
Humble O&R Co.	Opelousas, La.	Absorption Plant	110,000 mcf		Under Constr.	August, 1949		Hudson	Hudson
Humble O&R Co.	Baytown, Texas	Pipe Stills	45,000 bbls.		Under Constr.	July, 1949		Foster-Wheeler	Foster-Wheeler
Humble O&R Co.	Baytown, Texas	Roof Replacing of Butyl Bldg.			Under Constr.			Staff	Staff
Humble O&R Co.	Jourdanton Field, Texas	Gasoline Plant	26,000 mcf		Under Constr.	Early 1950			Hudson
* Humble Oil & Refining Company	Tomball Field, Texas	Additional Compression Facilities	10,000 mcf		Under Constr.	Sept., 1949		Fluor	Fluor
Hutex Oil & Refining Co.	Hardin, Tex.	Fractionators for Solvents	1,000 bbls.	$50,000	Under Constr.	July, 1949		Staff	Staff
Jefferson Chem. Co.	Austin, Texas	Central Research Facilities			Under Constr.	Sept., 1949		Staff	Staff
*Jefferson Chem. Co. Inc.	Port Neches, Tex.	Increase Capacity			Engineer	1950		Staff	
Lone Star Gas	Dallas, Texas	Hypersorption Plant	60 mcf		Design & Eng.	1949	Union Oil Co.	Foster-Wheeler	Foster-Wheeler
Magnolia Pet. Co.	Kilgore, Texas	Increase Propane Recovery	Unchanged		Under Constr.	Aug., 1949		Staff, Delta	Delta
Magnolia Pet. Co.	Seelignon Field, Texas	Gasoline and Cycling	70,000 mcf Casinghead 150,000 mcf Cycled		Under Constr.	Sept., 1949		Hudson	Hudson
Midland Gasoline Co.	Conroe Field, Texas	Enlarge Gasoline Plant	100,000 gals.		Under Constr.	Dec., 1949		Gaso. Plant	Gaso. Plant
Monsanto Chemical Co.	Columbia, Tenn.	Smoke Washing Unit		$750,000		Completed		Staff	Rust Eng.
Pan American Refining Corp.	Texas City, Texas	Expand Chemical Research Facilities			Postponed	Postponed		Staff, H. K. Ferguson	Staff, H. K. Ferguson
Pan American Refining Corp.	Texas City, Tex.	Revamping Crude Unit			Engineering	Late 1949		Tellepsen	Tellepsen
*Panhandle Producing & Refining Co.	Agua Dulce, Texas	Two Gas Compressor Plants		$170,000		Completed			D. C. Thompson
Panhandle Producing & Refg. Co.	Wichita Falls, Texas	Cat. Cracker	1,500 bbls.	$1 million	Under Constr.	March, 1950	U.O.P.	U.O.P., J. & L. Constr.	J. & L. Constr.
Phillips Chemical Co.	Etter, Tex.	Anhydrous Ammonia	†70,000 tons year	$5.3 million	Under Constr.	July, 1949	Chem Constr.	Chem. Constr.	Brown & Root
Plymouth Oil Co.	Rankin, Texas	Gas Compression, Absorp.	70,000 mcf	$5½ million	Under Constr.	1949-50			Hudson
The Pure Oil Co.	Nederland, Tex.	Wax Fractionation	200 bbls.		Under Constr.	Sept., 1949	Texaco	Lummus	Lummus
Shamrock Oil & Gas Co.	Sunray, Texas	Increase Topping & Cracking Facilities	10,000 bbls.	$300,000	Under Constr.	3rd Qtr., 1949	U.O.P.	Staff	Staff
Shamrock Oil & Gas Co.	Sunray, Tex.	Gas-Compressor Unit	2900 hp.	$500,000	Under Constr.	Completed		Staff	Staff
Shell Chem. Co.	Houston, Texas	Extend Acetone Facilities				July, 1949		Braun	Braun
*Shell Oil Co.	Houston, Texas	Lube Plant Utilities			Under Constr.	1949		Fluor	Fluor
*Shell Oil Co.	Houston, Texas	Wax Finishing Unit			Under Constr.			Fluor	Fluor
Shell Oil Co.	Provident City, Tex.	Gas Stripping Plant	60,000 mcf		Designing	1st qtr., 1950		Fluor	Fluor
Shell Oil Co.	Notrees, Texas	Extension TXL Plant	30,000 mcf		Under Constr.	Early 1950		Brown & Root	Brown & Root
Shell Oil Co.	Denver City, Texas	Gas Compression, Absorp. Addition	30,000 mcf		Under Constr.	Late 1949		Fluor	Fluor
*Sid Richardson Gasoline Co.	Keystone, West Texas	Nat. Gasoline Plant	115,000 mcf			Completed			
Sinclair Prairie Oil Co.	Midway Lane Field, Texas	Gas Compression			Under Constr.	Completed			
Skelly Oil Co.	Skellytown, Tex.	Expand Gasoline Plant			Under Constr.	Fall, 1949			J. E. Carlson
Southern Minerals Corp.	Stratton Field, Texas	Gas Compression Addition			Under Constr.	1st Qtr., 1949			
*Stacey-Dresser Eng.	Stinnett, Texas	Desulfo Plant	2,750 mcf			Completed		Panhandle Eastern Pipe Line Co.	Panhandle Eastern Pipe Line Co.
Stanolind O&G Co., Opr.	Fullerton Field, Texas	Gasoline Plant	55,000 mcf		Under Constr.	Jan., 1950		J. & L. Constr.	J. & L. Constr
Stanolind O&G Co.	Brownsville, Tex.	Chemical Plant			Under Constr.	Jan. 1, 1950		Badger	Badger
Stanolind O&G Co.	Levelland Field, Texas	Gasoline Plant			Under Constr.	1950		Brown & Root	Brown & Root
Stanolind O&G Co.	N. Cowden, Tex.	Gasoline Plant	75,000 mcf		Engineering	1950		Stearns-Roger	Stearns-Roger
Sun Oil Co.	Starr Co., Texas	Gasoline Plant	35,000 mcf	$4 million	Under Constr.	Sept., 1949	Pet. Eng.	Pet. Eng.	Pet. Eng.
Tex. Natl. Gas Corp. & Slick-Urschе Oil Co.	Rankin, Tex.	Gasoline Plant	55,000 mcf		Under Constr.	Late 1949		Tex. Natl. Gas Corp.	Tex. Natl. Gas Corp.
The Texas Co.	Port Arthur, Texas	Lube & Wax Additions	†37,500 Crude †2,500 bbls. Oil		Under Constr.	July, 1949		Foster-Wheeler	Foster-Wheeler
The Texas Co.	Tijerina-Canales Field, Texas	Gas Compression	6000 mcf		Under Constr.	Oct., 1949			

* CONTINUED ON PAGE 91

How would YOU insulate these steam tubes?



These 3½" downtake tubes connecting the lower drum with the bottom waterwall headers operate at 375° F. Specifications call for 2" of 85% Magnesia insulation with sewed canvas finish. Would you insulate each pipe individually, as shown at A, or would you box them in with half sections of pipe covering on the ends, and block insulation between, as shown at B?

HERE'S WHAT THE ARMSTRONG ENGINEER RECOMMENDED:

In this case the Armstrong Engineer recommended Method B. His calculations showed that from a material and labor cost standpoint it would be less expensive to insulate the three tubes as one unit. Method B also cuts down the amount of insulation surface from which heat is lost by radiation. As there is practically no maintenance on tubes of this kind, the fact that Method A allows for easier access for repair work did not have to be considered.

Had the tubes been spaced several inches farther apart, or if maintenance had been a problem, then Method A would have been the most practical to use.

Often, the dividing line between two methods of solving a certain insulation problem is pretty finely drawn. When these cases present themselves, Armstrong engineers take pride in their ability to arrive at a specification which will provide the best job. If you consult the Armstrong Office nearest you before planning your next insulation job, they will be glad to offer you their thinking on any problems you may have. Their solutions can often save you time and money.

FREE BOOKLET

Write today for your free copy of the 28-page booklet, "Armstrong's Industrial Insulations." This booklet contains specifications for application of both heat and low-temperature insulations and an insulation chart listing types and thicknesses of insulation for all temperatures. Write to Armstrong Cork Company, Industrial Insulation Dept., 7507 Maple Ave., Lancaster, Pennsylvania.

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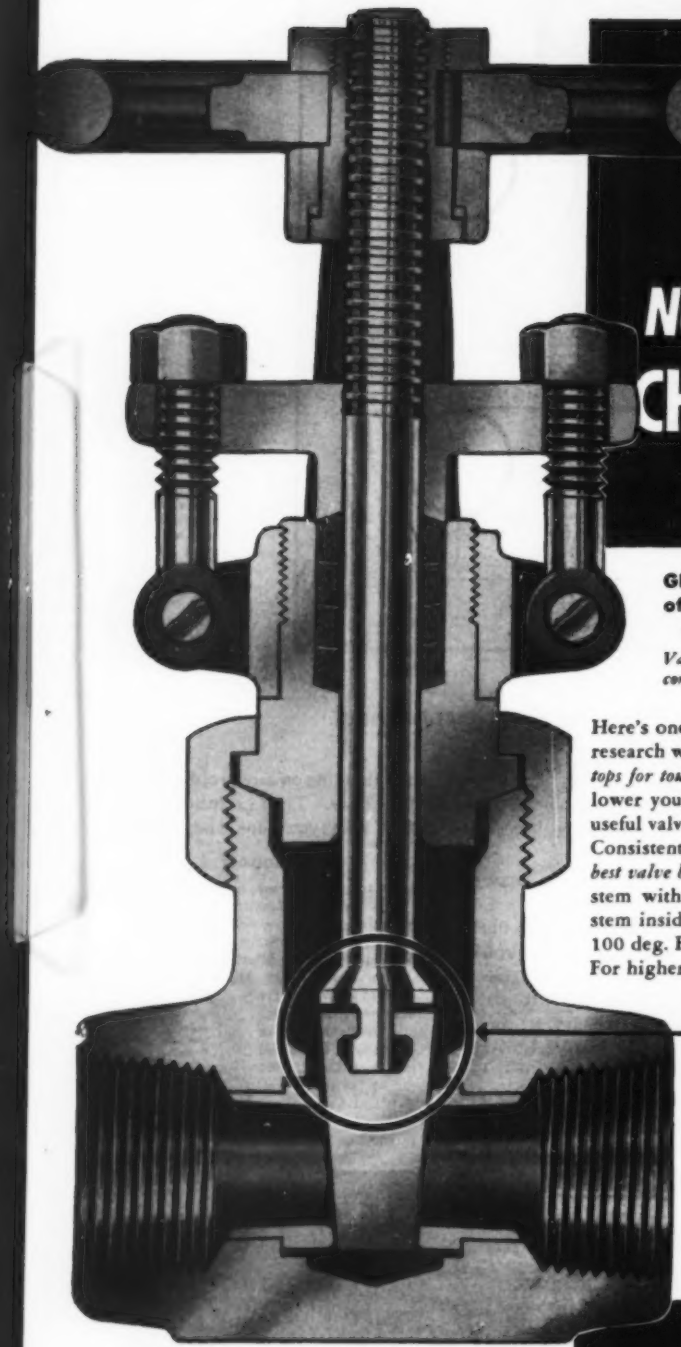
Complete Contract Service For All Temperatures

From 300° Below Zero — To 2800° Fahrenheit



New Design Feature
CHAPMAN VALVE
List 960

Gives more than 50% increase in strength of stem and wedge gate connection...meets the most extreme operating conditions.

Valve stems and gates with the new scientifically designed connection are interchangeable with all List 960 Valves now in service

Here's one more result of the year after year program of research which Chapman carries on to make the List 960 *tops for toughness.* Reason why this small gate valve can lower your maintenance cost — give you more years of useful valve life.

Consistently you will find the Chapman List 960 is *your best valve buy.* It is available in sizes ¼" to 2" . . . rising stem with yoke (as illustrated). Also available rising stem inside screw type. For pressure range 2000 lb. at 100 deg. F., 380 lb. at 1000 deg. F.

For higher pressures specify List 990.

Secret of this 50% increase in strength of the stem and wedge gate connection lies in its new design which compensates at points where excessive stresses can develop.

And don't forget the wear resisting and non-galling properties of the hard heat treated seat rings and the 800 Brinell hardening of the wedge faces by the exclusive Malcomizing Process.

The Chapman Valve Mfg. Co., Indian Orchard, Massachusetts

REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
The Texas Co.	Chalk-Hill Field, Texas	Gas Compression, Absorp.	2000 mcf	.....	Under Constr.	August, 1949	.....	.....	.....
The Texas Co.	Withers Field, Tex.	Expand Compression	9000 mcf	.....	Under Constr.	July, 1949	.....	Telleysen	Telleysen
United Gas Pipe Line Co.	Karnes City, Texas	Natural Gas & Condensate Processing Plant	10,000 mcf	$1 million	Under Constr.	Jan., 1950	.....	Delta	Delta
West Texas Gas Co.	Fritch, Texas	Enlarge Compressor Station	3180 Bhp	.....	Projected	Aug., 1949	.....	Staff	.....
ROCKY MOUNTAIN									
American Gilsonite Co. Co.	Bonanza, Utah	Gilsonite to Crude Oil Pilot Plant	300 tons	$300,000	Engineering	July, 1949	.....	Staff	Staff
The Carter Oil Co.	Billings, Mont.	Crude Cat. Crk.	30,000 bbls.	$15 million	Under Constr.	3rd Qtr., 1949	.....	U.O.P., S.O.D., Fluor	Fluor
Continental Oil Co.	Billings, Mont.	Complete Ref. Cat. Crack	7,500 bbls.	$9.5 million	Under Constr	Oct., 1949	U.O.P.	U.O.P., J. & L. Constr.	J. & L. Constr
Empire State Oil Co.	Thermopolis, Wyoming	Crude, Vacuum Units	5,000 bbls.	$325,000	Under Constr.	July, 1949	.....	Ref. Eng.	Ref. Eng.
New Mexico Asphalt Refg. Co.	Artesia, N. M.	Crude Unit	7,500 bbls.	$350,000	.....	Completed	.....	Geo. Armistead	Staff
*Northern Natural Gas Co.	Palmyra, Neb.	Compressor Add.	1,600 hp.	.....	Under Constr.	1949	.....	.....	Fluor
The Pure Oil Co.	Worland, Wyo.	Gasoline Plant	.....	.....	Projected	.....	.....	.....	.....
Salt Lake Refining Co.	Salt Lake City, Utah	Cat. Cracking Units	25,000 bbls.	$10 million	Design	Jan., 1951	.....	.....	.....
Skelly Oil Co.	Lea County, N. M.	Expanding Gasoline Plant	60,000 gals.	.....	Under Constr.	Mid 1949	.....	.....	J. E. Carlson
*Standard Oil Co. (Indiana)	Casper, Wyo.	Cat. Cracking Unit	.....	.....	Completed	1949	.....	.....	.....
Texas Gulf Sulphur Co.	Worland, Wyo.	Sulfur Recovery, Gas Treating Plants	30,000 mcf	.....	Under Constr.	.....	.....	Girdler, C. F. Braun, Foster-Wheeler	Girdler
WEST COAST									
*General Petroleum Corp.	Torrance, Calif.	H_2S Absorption Plant	.....	.....	Engineering	3rd Qtr., 1950	.....	Badger	Badger
*General Petroleum Corp.	Torrance, Calif.	Noded Spheroid	.....	$400,000	Under Constr.	July, 1949	.....	Staff	Chicago Bridge & Iron Co.
*General Petroleum Corp.	Torrance, Calif.	Cooling Tower	.....	.....	Under Constr.	Aug., 1949	.....	Staff	Fluor & Staff
General Petroleum Corp.	Torrance, Calif.	Chemical Treating Facility	.....	.....	Under Constr.	Late Fall, 1949	.....	Staff	Staff
*Hancock Chemical Co.	Long Beach, Calif.	H_2S Recovery System	50 tons	$1 million	Designing	Jan., 1950	.....	Badger	Badger
Hancock Oil Co.	Long Beach, Calif.	Ethylene Glycol Unit	60,000 lbs.	.....	Engineering	3rd Qtr., 1950	.....	Badger	Badger
Hercules Powder Co.	Hercules, Calif.	Ammonia Plant	.....	.....	Under Constr.	Summer 1949	.....	Staff	Bechtel
*Ohio Oil Co.	S. Coles Levee, Calif.	Gas Lift	1,800 hp.	.....	Designing	1949	.....	Fluor	Fluor
*Richfield Oil Corp.	Cuyama, Calif.	Absorption, H_2S Removal Plant	1,500 mcf	.....	Designing	1949	.....	Fluor	Fluor
*Richfield Oil Corp.	Cuyama, Calif.	Compressor Plant Exten.	2,640 hp.	.....	Designing	1949	.....	Fluor	Fluor
Shell Chem. Corp.	Domingues, Cal.	Add Acetone	.....	.....	.....	Completed	.....	Braun	Braun
Shell Oil Co.	Wilmington, Cal.	Extend Cracking Plant Compressors	.....	.....	Under Constr.	Middle 1949	.....	Fluor	Fluor
Standard Oil Co. of Calif.	Bakersfield, Calif.	Crude Dist.	10,000 bbls.	$7.7 million	Under Constr.	Mid 1949	Braun	Braun	Braun
Standard Oil Co. of Calif.	Bakersfield, Calif.	Thermal, Crk., Gaso. Stabil. Gaso. Treating	9,000 bbls.	.....	Under Constr.	Late 1949	U.O.P.	U.O.P.	Braun
Standard Oil Co. of Calif.	El Segundo, Cal.	Cracked Naphtha Rerun Still	22,000 bbls.	$2.6 million	Under Constr.	Aug., 1949	.....	Braun	Braun
Union Oil Co of California	Oleum, Calif.	Asphalt Refined Oil Loading Facilities	.....	$457,000	Under Constr.	Late 1949	.....	Early Constr.	Early Constr.
Union Oil Co. of California	Oleum, Calif.	Revision of Refining Facilities	.....	$4 million	Under Constr.	Late 1949	.....	Parsons, E. & A.	Ref. Maint.
Union Oil Co. of California	Oleum, Calif.	Improvements to Compound & Barrel Handling Facilities	.....	$1.5 million	Under Constr.	Late 1949	.....	Matthews Conveyor Co., J. H. Montgomery & Co.	Early, C. N., Peterson, Matthews Conveyor
Union Oil Co of California	Oleum, Calif.	Duo-Sol Unit	6,000 bbls.	$3 million	Under Constr.	July, 1949	Max Miller	Max Miller	Fluor
Union Oil Co. of California	Oleum, Calif.	Tankage and Utilities	.....	$1.8 million	Engineering	Late 1949	.....	Parsons	Eaton & Smith
Union Oil Co. of Calif.	Brea Olinda, Calif.	Enlarge Absorption Facilities	10000 mcf	.....	Engineering	4th Qtr., 1949	.....	Parkhill-Wade	.....
FOREIGN									
Agwi Pet. Corp.	Fawley, Eng.	.....	120,000 bbls.	$140 million	Projected	1952	.....	.....	.....
*Anglo-American Oil Co.	Fawley, England	Refinery Expansion	110,000 bbls.	$150 million	Under Constr.	Late 1952	.....	Foster-Wheeler	Foster-Wheeler
Anglo-Iranian Oil.	Abadan, Iran	Gas Plant	28,000 mcf	$2 million	Under Constr.	1950	.....	Badger	Badger
Anglo-Iranian Oil.	Abadan, Iran	Cat. Cracker	30,000 bbls.	.....	Under Constr.	.....	.....	Foster-Wheeler	Foster-Wheeler
Anglo-Iranian Oil.	Abadan, Iran	Solvent Dewaxing	400 bbls.	.....	Under Constr.	.....	Texaco	Badger	Badger
Anglo-Iranian Oil.	Isle of Grain, Thames and Medway Estuary, Eng.	Wax Fractionation	60,000 bbls.	$120 million	Planning	1952	Texaco (Lube Unit)	Lummus	Lummus
Anglo-Transvaal Consolidated Investment Co.	Vall River Union, South Africa	Synthetic Gasoline and Diesel Oil Plant	.....	$80-90 million	Contracted	.....	.....	Hydrocarbon Research	.....
*Arabian American Oil Co.	Saudi, Arabia	H_2S Treating Plant	1,500 mcf	.....	Designing	1949	.....	Fluor	.....
Arabian American Oil Co.	Abqaiq, Saudi Arabia	Crude Oil Stabilizer	300,000 bbls.	$4,800,000	Under Constr.	July-Sept., 1949	.....	Staff and Fluor	Staff and Fluor
Arabian American Oil Co.	Abqaiq, Saudi Arabia	Steam Power Plant, etc.	20,000 kw	$9,400,000	Under Constr.	July-Sept., 1949	.....	Staff and Fluor	Staff and Fluor
Australian Shell Oil Co.	Geelong, Victoria, Australia	New Refinery	.....	$4.8 million	Under Constr.	1951	.....	.....	.....

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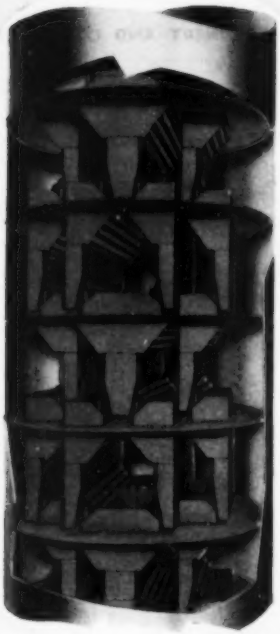
HOPE

McCarthy

DOW

SHAMROCK



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To Mr. Executive:

If your trade mark is not shown among the progressive companies who have purchased the finest device for vapor-liquid and liquid-liquid contacting – you may well wonder why.

The Koch Kaskade tray is the finest fractionating device that has been developed in 30 years, and is far superior to the conventional bubble tray in capacity, efficiency and economy.

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Paisley, Scotland

REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Arabian American Oil Co.	Ras Tanura, Saudi Arabia	Add Power Generating Unit	10,000 kw	$1,750,000	Under Constr.	July-Sept., 1949		Staff and Fluor	Staff and Fluor
Arabian American Oil Co.	Ras Tanura, Saudi Arabia	Refinery Additions			Under Constr.	1949		Bechtel	Bechtel
*Arabian American Oil Co.	Ras Tanura, Saudi Arabia	Add Power Generating Unit	10,000 kw.		Under Constr.	1949		Staff, Fluor	Staff, Fluor
Azienda Generale Italiana Petroli	Rome, Italy	Add to Plant	24,000 bbls.		Projected				
*Azienda Generale Italiana Petroli	Palermo, Italy	Marine Fuel Plant	7,500 bbls.						
Bahrein Pet. Co., Ltd.	Bahrein Island	Expansion Program		$8.3 million	Under Constr.	Oct., 1949		U.O.P., Bechtel	International, Bechtel, Inc.
Bahrein Pet. Co., Ltd.	Bahrein Island	Crude Still, Utilities	55,000 bbls.	$9.1 million	Planned	June, 1950		Lummus, Bechtel	
*British-American Oil Co.	Montreal East, Quebec	Crude Oil Topping and Decarbonizing Unit			Under Constr.	Sept., 1949			
British American Oil Co., Ltd.	Montreal, East P.Q., Canada	Cat. Cracking and Cat. Poly	13,300 bbls.		Under Constr.	4th Qtr., 1949	Kellogg-U.O.P.	Kellogg	Kellogg
British Pet. Chem., Ltd.	Grangemouth, Scotland	Petro-Chem		$20 million	Planned			S. & W. Badger	S. & W. Badger
Burmah Oil Co.	Burma	Furfural Plant Solvent Dewaxing, Wax Manufacturing Units	1,000 bbls.	$600,000	Designing		Texaco	Badger	
Burmah Oil Co.	Syriam, Burma	Thermafor Clay Revivification	66 tons	$150,000	Design	1949	Max Miller, Socony-Vacuum	Max Miller	
*Cabot Carbon, Ltd. Godfrey L. Cabot, Inc.	Ellesmere Port, Cheshire, Eng.	Carbon Black Plant	50,000 lbs.		Under Constr.	1950		Simon-Carves, Ltd.	Simon-Carves, Ltd.
Caltex & Spanish Associate	Cartagena, Spain	Refinery	15,000-20,000 bbls.		Proposed	March, 1951			
Caltex Pet. Maatschappij, N. V.	Rotterdam, Holland	Complete Refinery	20,000 bbls.	$18 million	Under Constr.	Feb., 1950		McKee, Badger, U.O.P.	McKee
Cie. de Raffinage Shell-Berre	Berre, France	Capacity Increase	47,000 bbls.		Planned				
Cie. Francaise de Raffinage	Gonfreville, France	Lube Unit	2,500 bbls.		Projected	1951	Texas	Kellogg-Lummus	
Cie. Francaise de Raffinage	Gonfreville, France	Distillation Unit	20,000 bbls.		Under Constr.	1950		Foster-Wheeler	Foster-Wheeler
Cie. Francaise de Raffinage	Provence, France	Topping Unit	20,000 bbls.		Under Constr.	1950		Foster-Wheeler	Foster-Wheeler
Cie. de Raffinage Shell-Berre	Petit Couronne, France	Lube Unit			Planned				
Companhia Brasileira de Petroleos S.A.	Rio Grande, Brazil	Topping, Thermal Cracking	3000 bbls		Authorized	1952	Foster-Wheeler		
Compania Espanola de Petroleos S.A. (C.E.P. S.A.)	Canary Islands, Spain	Furfural Refining, Solvent Dewaxing, Wax Fractionation Units	5,000 bbls.	$4½ million	Under Constr.	Early 1950	Texaco, Standard, N.J.	Foster-Wheeler	Foster-Wheeler
Conselho Nacional do Petroleo	Mataripe, Bahia, Brazil	Thermal Cracking Refinery	2500 bbls.	$2.5 million	Under Constr.	Jan., 1950		Kellogg	Kellogg, Staff
Conselho Nacional do Petroleo		Thermal Cracking Refinery	45,000 bbls.		Design	1952			Fives, Lille, Schneider, Staff
Consolidated Ref., Ltd.	Haifa, Palestine	Crude Plant	80,000 bbls.		Planned	1950		Badger	Badger
Consolidated Ref., Ltd.	Haifa, Palestine	General Facilities			Under Design			Badger, Ltd.	
Consolidated Ref., Ltd.	Haifa, Palestine	Lube Plant	2,500 bbls.		Designing		Texaco, Juik	Lummus, Kellogg	Lummus, Kellogg
Creole Pet. Corp.	Amauy Bay, Venezuela	Crude Stills	60,000 bbls.	$175 million	Under Constr.	1951		S.O.D.	Foster-Wheeler, J. G. White
Creole Pet. Corp.	El Roble Field, Venezuela	Repressuring			Planning				
*Danish Government	Denmark	Refinery	21,000 bbls.		Planned				
Egyptian Government	Cairo, Egypt	Crude Plant						Lummus	Lummus
Excelsior Refineries	Lloydminster, Alberta, Canada	Moving Refinery	3000 bbls.	$500,000	Under Constr.	Sept., 1949	U.O.P.	U.O.P.	
Hi-Way Refineries, Ltd.	Saskatoon, Saskatchewan	Crude Topping Unit	2,000 bbls.		Under Constr.	Dec., 1949	U.O.P.	Ref. Eng.	Ref. Eng.
Hi-Way Refineries, Ltd.	Saskatoon, Saskatchewan	Thermal Cracking Unit	500 bbls.		Under Constr.	Dec., 1949	U.O.P.	Ref. Eng.	Ref. Eng
Imperial Oil, Ltd.	Edmonton, Canada	Increase Capacity	15,000 bbls.	$2½ million	Under Constr.	July, 1949		Staff, Barnes	Barnes
Imperia Oil, Ltd.	Leduc Field, Canada	Gas Absorption Plant	24,000 mcf	$6.5 million	Under Constr.	Middle 1950		Braun	Braun
Industrie Chimiche Italiane Petroli	Mantua, Italy	Crude	4,800 bbls.						
Industria Nazionale Petroli e Trasformaziche	Massa Carrara, Italy	Refinery	40,000 bbls.						
Italo-American Esso-Anic	Leghorn, Italy	Capacity Increase	28,700 bbls.						
Italo-American Esso-Anic	Bari, Italy	Capacity Increase	38,300 bbls.						
Kuwait Oil Co.	Kuwait	Topping Unit	20,000 bbls.	$2 million	Under Constr.	July, 1949		Badger	Badger
L'Alliance Petrofina	Antwerp, Belgium	Refinery	21,000 bbls.		Planned				
*Manchester Oil Refinery, Ltd.	Partington, England	Cat. Crk., Lube, Reforming	20,000 bbls.		Projected				
Mene Grande Oil Co.	Puerto la Cruz, Venezuela	Refinery	30,000 bbls.						
*Monsanto Chemical Co.	Britain	Add Polystyrene			Design	Early 1950		Staff	Staff
National Oil Refineries, Ltd.	Llandarcy, Wales	Crude and Refin.	40,000 bbls.	$36 million	Designing			Badger	Badger
National Oil Refineries, Ltd.	Llandarcy, Wales	Furfural Refining, Solvent Dewaxing, Wax Fractionation Units	1,300 bbls.				Texaco	Badger	Badger
National Oil Refineries, Ltd.	Llandarcy, Wales	SO2 Solvent Extraction	3,000 bbls.		Contracted			H. W. P.	
*Panther Oil and Grease Co.	Leaside, Toronto, Canada	Grease and Compounding Plant			Projected				
Pechelbronn S. A. E. M.	Merkwiller, France	Capacity Increase	1,550 bbls.		Authorized	1950			

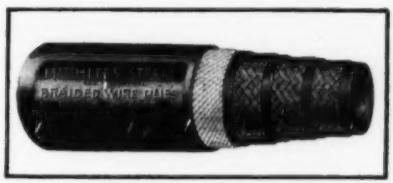
■ CONTINUED ON PAGE 96

What Do You Want in a Hose?

Protection from Bursting?

PICK MATCHLESS WIRE BRAID

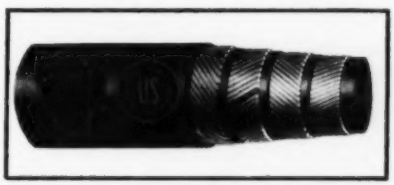
Carcass has a super quality, steam-resistant rubber tube, braided plies of steel wire, a spiral asbestos cord ply and a heat resistant rubber cover. When, after long use, the rubber tube finally fails, the steam merely trickles through and gives ample warning. Matchless never bursts—it's super safe.



Cooler Cover?

PICK U. S. ROYAL ASBESTOS CORD

Made with plies of super strength asbestos cords wound spirally around the heat and steam-resistant tube. Each cord is deeply imbedded in the rubber, preventing any shearing action due to expansion or flexing. Will not burn a man because cover runs cool.



Lightweight Wash-Down Hose?

PICK MATCHLESS CARBOLIZED FIRE HOSE

For use in refineries, or on any hose-reel cart for fire protection and wash-down purposes. Very light and strong. Has an improved type rubber tube and tough neoprene cover, plus strong Ustex* fabric. Light, strong, flexible. Easy flattening characteristics when reeled. Available in black or white. Capped and reinforced ends.

**Reg. trade name of U. S. Rubber*

"U.S." HAS A HOSE FOR EVERY KIND OF REFINERY USE

MADE ONLY BY

U.S. RUBBER

SERVING THROUGH SCIENCE

UNITED STATES RUBBER COMPANY

REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Petro Carbon, Ltd.	Partington, England	Cat. Cracker Lube & Reform	20,000 bbls.						
Petro Chem., Ltd.	Partington, England	Petro Chemicals	2,000 bbls.	$16 million	Under Constr.	1950	Petro-Carbon	Petro-Carbon	Petro-Carbon
Petróleos Mexicanos	Poza Rica, Mex.	Gas Purification, Pressure Maintenance, etc.		$13 million	Contracted	Early 1950		McKee	McKee
Petróleos Mexicanos	Salamanca, Mex.	Crude, Gascil, Cracking	30,000 bbls.	$12 million	Under Constr.	Early 1950	U.O.P.	McKee	McKee
Philblack, Ltd.	Avonmouth, England	Carbon Black Plant	80 million lbs. Yearly	$5 million	Contracted	1950	Phillips	H. W. P.	H. W. P.
Porto Marghera Rfg.	Venice, Italy	Enlarging Crude Unit			Contracted			H. W. P.	H. W. P.
Raffineries de Petrole de la Gironde	Ambes, France	Refinery	13,000 bbls.	$7.8 million	Reconstr.	Early 1950		U.O.P., McKee	McKee
Raffineries Francaises de Petrole de l'Atlantique	St. Nazaire, France	Consolidate Refineries	7,100 bbls.						
Raffinerie di Napoli, S. P. A.	Naples, Italy	Topping Unit	10,000 bbls.		Under Constr.	Mid 1949		Staff	Staff
Raffinerie di Napoli, S .P. A.	Naples, Italy	Solvent Treating	1,000 bbls.		Under Constr.	Early 1950	Texaco	Staff	Staff
*Raffinerie Siciliane Oli Minerali, S.A.	Augusta, Sicily	Crude Refinery	10,000 bbls.		Designing	Early 1950	U. O. P.	U. O. P., Delta	S. T. I. I.
Refinaria de Petróleo dó Distrito Federal S.A.	Rio de Janeiro, Brasil	Complete Refinery	10,000 bbls.		Authorised				
Refinaria e Explo-racao de Petróleo	Capuava, S. Paulo, Brasil	Thermal Cracking Refinery	20,000 bbls.		Authorised			Pan American Hydrocarbon Res., Inc.	Czech, Fact. Metal Work & Mech. Constr.
Richmond Exploration Co.	Lake Maracaibo, Venezuela	New Refinery	35,000 bbls.		Engineering	June, 1950			
Scottish Oil, Ltd.	Grangemouth, Scotland	Crude	28,000 bbls.	$28 million	Designing			Kellogg	Schneider
Scottish Oils, Ltd.	Grangemouth, Scotland	Cat. Crk.	5,000 bbls.		Planned				
Shell Chem. Corp.	Thornton, Eng.	Petro-chem		Several millions	Under Constr.	Aug., 1949			
Shell Refining & Marketing Co. Ltd.	Stanlow, Eng.	Refinery Expansion	50,000 bbls.		Under Constr.				
Shell Ref. & Marketing Co. Ltd.	Shell Haven, England	Refinery Expansion	60,000 bbls.						
Shell Oil Co. (Venezuela)	Punta Cardón, Venezuela	Complete Refg.	40,000 bbls.		Under Constr.	Mid 1950		Lummus	Lummus
Shell Oil Co. of Canada, Ltd.	Montreal, East Quebec, Canada	Fluid Cat. Cracker, Vac Flashing, Gas Recovery, Polymer, Treating	35,000 bbls.		Under Constr.	Late, 1950		Staff	Fluor, Ltd., McKee
Shell Refining & Marketing Co., Ltd.	Hamburg-Harburg, Germany	Refinery	8950 bbls.		Under Constr.	Late 1949			
Société Generale des Huiles de Pétrole	L'Avera, France	LPG Units			Under Constr.	Mid 1950	Kellogg	Kellogg	Staff
Société Generale des Huiles de Pétrole	Dunkirk, France	Crude Reform.	33,000 bbls.		Under Constr.	Mid 1951	Lummus, Kellogg	Lummus, Kellogg	Lummus, Kellogg
Société Generale des Huiles de Pétrole	Dunkirk, France	Furfural Refining, Solvent Dewaxing, Wax Fractionation Units	2400 bbls.		Designing	Mid 1951	Texaco	Lummus	Lummus
Societe Industriel Belgique de Petrole	Antwerp, Belgium	Crude, Cracking Reforming	30,000 bbls.		Designing	Mid 1951			
Societa per Azioni Raffineria Padana Oli iMinerali	San Martino di Trecate, Italy	Refinery	13,000 bbls.		Proposed				
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	Contact Plant			Under Constr.	Mid 1949		Staff	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	MEK Unit	1,000 bbls.		Design	Early 1950	Texaco	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	Solvent Treating	1,100 bbls.		Design	Mid 1950	Juik	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	Furfural Unit	1,000 bbls.		Under Constr.	Mid 1949	Texaco	Staff	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	Grease and Compounding Plant			Under Constr.	Early 1950		Staff	Staff
Socony-Vacuum Francaise	Frontignan, France	Capacity Increase	13,500 bbls.		Under Constr.	Aug., 1949		Staff	Staff
Standard Francaise des Pétroles	Port Jerome, France	Capacity Increase	30,000 bbls.		Authorised				
Standard Francaise des Pétroles	Port Jerome, France	Dewaxing Plant	1,000 bbls.		Planned				
Standard Francaise des Pétroles	Port Jerome, France	Desasphalting Plant	2,000 bbls.		Planned				
Standard Oil Co., (N.J.)	Belgium	Refinery	33,000 bbls.		Planned	1952			
Stora Kopparberg S. Bergslags Co.	Gotheborg, Sweden	Crude, Ther. Cracking			Under Constr.	Mid 1949		Lummus	Lummus
Trent Oil Prod. Development Co.	North Shields, England	Crude Plant	11,500 bbls.	$4 to $8 million	Plans approved				
Union Petrol Refinery, Ltd.	Johannesburg, Union of South Africa	New Refinery		$20 million	Projected				
Venezuela Gulf Refining Co.	Puerto la Cruz, Venezuela	Refinery	30,000 bbls.		Under Constr.	July, 1950		Lummus	Lummus
Venezuelan Pet. Co. (Sinclair)	Puerto la Cruz, Venezuela	Refinery	35,000 bbls.		Under Constr.			Frederick Snare Corp.	Frederick Snare Corp.
Yacimientos Petroliferos Fiscales	Buenos Aires, Argentina	New Refinery	28,000 bbls.		Engineering	Late 1950		Kellogg	Kellogg
Yacimientos Petroliferos Fiscales	La Plata, Argentina	Crude Topping, Gaso Treating	50,000 bbls.	$2.8 million	Under Constr.	Mid 1949		Houdry Process Cat. Constr.	Cat. Constr
Yacimientos Petrolejeros Fiscales Bolivianos	Sucre, Bolivia	Crude Plant	3,000 bbls.			2nd Qtr., 1949		Foster-Wheeler	Foster-Wheeler
YPF Bolivianos	Cochabamba Bolivia	Topping & Reforming Units	5,000 bbls.			1st Qtr., 1950		Foster-Wheeler	Foster-Wheeler

* First appearance in tabulation. † Added capacity.

DU PONT TETRAETHYL LEAD COMPOUNDS

DuPont Services...

are fitted to your needs

Available to the Refining Industry are the specialized services which Du Pont provides in connection with its Tetraethyl Lead Compounds

Whether it is a problem of determining lead susceptibility of stocks or of checking octane number on finished blends, there is a convenient District Laboratory to help. On safety or health problems associated with lead blending or handling, safety and medical personnel are always available to work with you.

These services—medical, safety, technical, and sales—stand ready at all times to assist in the solution of any problems involving the use of Du Pont TEL Compounds and other additives.

MEDICAL SERVICE

SAFETY SERVICE

DISTRICT LABORATORIES

SALES SERVICE

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MEDICAL SERVICES cooperate with the refiner to maintain the highest degree of industrial hygiene possible among employees engaged in the handling of tetraethyl lead compounds. Periodic examination of all personnel working with TEL is only one part of the services which help in the establishment of safe operating procedures and the indoctrination of personnel in these approved methods.

DISTRICT LABORATORIES, five of which are conveniently located throughout the country, provide prompt, dependable laboratory tests. They are equipped and staffed with experienced men to furnish technical assistance in the application and use of Du Pont TEL compounds as well as other additives.

Provides These Services
to Help You Produce Better Fuels...

SAFETY SERVICES are ready day and night to give prompt aid and advice on safety problems associated with the handling of TEL compounds or of fuels containing them. Safety service representatives are completely equipped with special instruments and tools and are available to refiners for use on safety problems.

DISTRICT OFFICES, located at Wilmington, Delaware; Chicago, Illinois; Tulsa, Oklahoma; Houston, Texas; and Los Angeles, California serve as centers through which the technical, safety and medical services are made available to you.

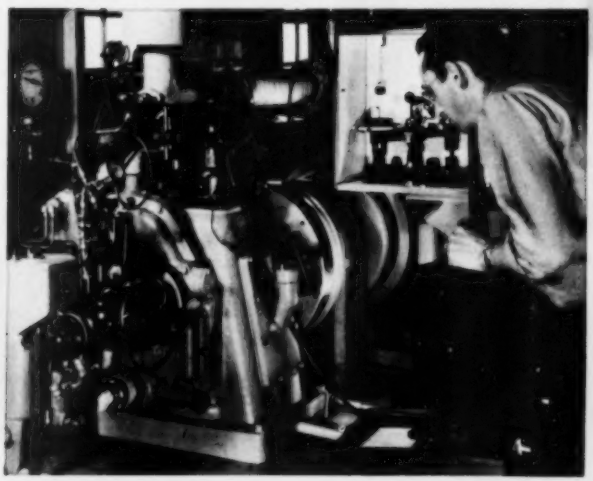
PLUS *a Long-Range Research Program to Help You Meet Changing Fuel Requirements*

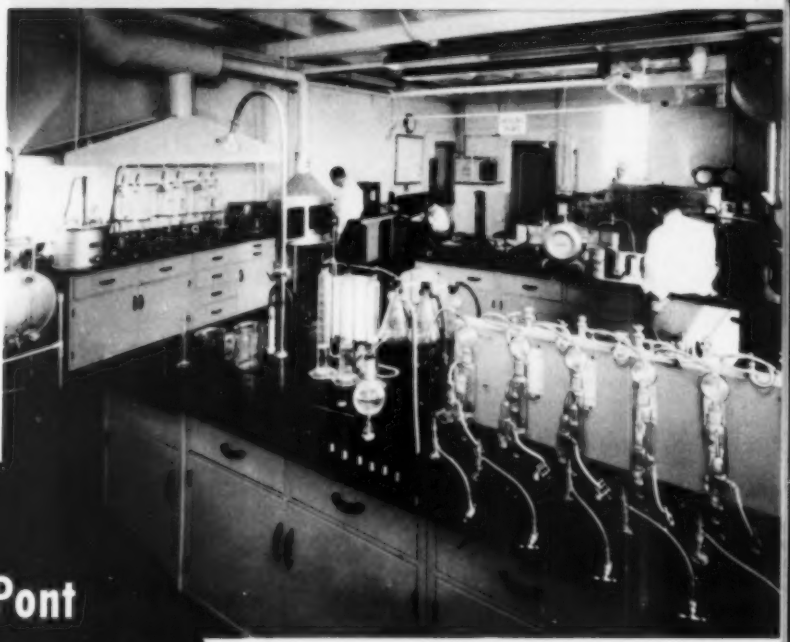
The development of new engines brings changes in fuel requirements. Likewise, changes in refining methods or sources of crude create differences in the basic characteristics of fuels. These and many additional factors affect the requirements placed on additives.

It is to help you meet these changing requirements that Du Pont is now engaged in a long-range program of Petroleum Chemicals research. This program is aimed at the improvement of present antiknock agents and other additives and the development of new ones to meet the higher performance standards which the future is sure to bring.

Supplementing the work of the Petroleum Chemicals Division laboratories is the Company-wide program of fundamental and applied chemical research, the results of which are constantly examined for application to Industry requirements.

Thus, Du Pont research is at work today to help you create better fuels—now and in the future.





Chemical section of a District Laboratory. Also equipped to make octane determinations, they render many helpful services in the use of all Du Pont additives.

Make Du Pont the Source for all of your Gasoline Additives

● Du Pont offers you one dependable source of supply for all of your gasoline additives. This complete line includes Gasoline Antioxidants, Metal Deactivator and Gasoline Dyes, as well as Tetraethyl Lead Compounds. These additives have been proved by many years use in the field. They are compatible with each other and are of uniform high quality. The Du Pont District Laboratory in your territory will be glad to assist you in evaluating these additives in your fuel and to make the proper recommendations.

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
PETROLEUM CHEMICALS DIVISION
Wilmington 98, Delaware

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Antioxidants • Dyes
Tetraethyl Lead Compounds—Aviation Mix—Motor Mix
Metal Deactivator

Increase of Refining Capacity Called for by ECA Program

By 1953, the scheduled end of the Marshall Plan for European Recovery, Western Europe's petroleum imports from the U. S. will drop to a "very low level," according to a booklet published by the Economic Cooperation Administration, giving data on petroleum and petroleum equipment involved in the program. By 1953, states the report, the "major part" of Western Hemisphere output will be used in this hemisphere and oil from the Middle East will be Europe's main source.

Under the program, refining capacity will be increased substantially within the European countries, and companies of the participating countries will increase their refining capacity in areas outside Europe. Meanwhile, companies of the participating countries also will increase their crude oil production outside Europe, these countries including mainly the United Kingdom, the Netherlands, and to a lesser extent France.

In the fiscal year 1949-1950, for the first time in European oil history, crude oil imports are scheduled at more than one half of the total European oil imports, compared with about one third in the prewar period.

Revised Plans

ECA financing of equipment up to the present time has been only a small part of the amount considered necessary by the participating countries. They estimated their equipment needs for the fiscal year 1949-1950 from all sources at an equivalent of $592 million worth, of which they expected to obtain $211 million worth from the United States. However, the ECA report indicated probability that the plans of the different countries will have to be revised, for in the aggregate they appear to be more abitious than economically justified.

The petroleum equipment programs of the individual companies for 1949-1950 can be evaluated only against the long-term programs of which they are a part, said the report. These programs, when added together would result in an increase in annual refining capacity in Europe from 27.5 million metric tons in 1948-1949 to 65.7 million tons in 1952-1953, and an increase outside Europe from 54.2 million tons in 1948-1949 to 72 million in 1952-1953. This would be an expansion of total refining capacity from 81.7 million tons annually in 1948-1949 to 137.7 million in 1952-1953, an increase of 56 million tons.

Crude oil production, nearly all overseas, according to the individual programs, would increase from 77 million metric tons in fiscal 1949 to 116 million tons in fiscal 1953, an expansion of 39 million tons.

Increases of such magnitude in refining capacity and crude oil production seem to be out of line with expected increases in consumption during the same period. ECA said there is little doubt, therefore, that the Organization for European Economic Cooperation and the ECA will recommend revisions in these programs after their analyses have been completed.

Specified Allowances

ECA's estimates make an allowance for a reduction in the petroleum equipment and an allowance for the value of equipment imported from dollar sources by subsidiaries of American companies to the extent that it will be financed by new dollar investments of their parent companies, which does not have to be financed out of European dollar income or ECA aid.

After these allowances are made, ECA estimates, on a provisional and highly tentative basis, that somewhat more than $100 million of equipment imports from dollar sources will have to be financed from European dollar resources or ECA aid.

The Marshall Plan countries are expected by ECA to use 48.7 million metric tons of petroleum products in the fiscal year 1949-1950. This is equal to about 975,000 barrels a day or 20,000 barrels a day less than was estimated by the participating countries. It is an increase of 57,000 barrels a day over the estimated 1948-1949 consumption and 374,000 barrels over the prewar level of 601,000 barrels a day. The United Kingdom, France, and Italy are expected to account for 65 percent of the total estimated consumption in 1949-1950, about the same percentage as prewar.

In the eight largest consuming countries, it is estimated that only 8 percent of all oil will be used for private motor cars and motorcycles, compared with 21 percent before the war, showing emphasis on uses aimed at recovery. In terms of total quantities, the amount expected to be used for private motor cars and motorcycles is 33 percent less than prewar, as a result of strict rationing in most of the countries. In contrast, consumption for all other transportation purposes is expected to increase by 45 percent. The industrial and agricultural uses of gasoline, kerosine, gas oil, diesel oil, and residual fuel oil are expected to more than triple, accounting for 34 percent of the total in fiscal 1950 compared with 6 percent in the prewar period. While petroleum products are essential for recovery, stated ECA, Europe will continue to be predominantly a coal economy. By fiscal 1953, oil will supply only about one ninth as much energy per capita in Europe as it does in the U. S. today.

ECA Estimates

To supply the petroleum considered essential in 1949-1950, ECA estimates that 52.7 million metric tons of crude oil and refined products—a little over a million barrels a day—will have to be imported by Marshall Plan countries, compared with 48.7 million tons in 1948-1949. Of the total imports, ECA estimates that 21.8 million tons—nearly 436,000 barrels a day—valued at $562.5 million on the basis of November 1948 prices, must be obtained from sources which require payment in dollars, that is, from American oil companies, compared with about 20.6 million tons in fiscal 1948-1949. The ECA estimate is nearly $100 million less than the estimates submitted by the participating countries of requirements from dollar sources. These totaled about $658.5 million.

The estimates indicate that Europe's imports of "dollar crude" in fiscal year 1949-1950 may be 11,374,000 metric tons, compared with 8,178,000 tons in 1948-1949. But imports of refined "dollar oil" are expected to drop to 10,412,000 tons from 12,379,000 tons.

Marshall Plan Implications Cited

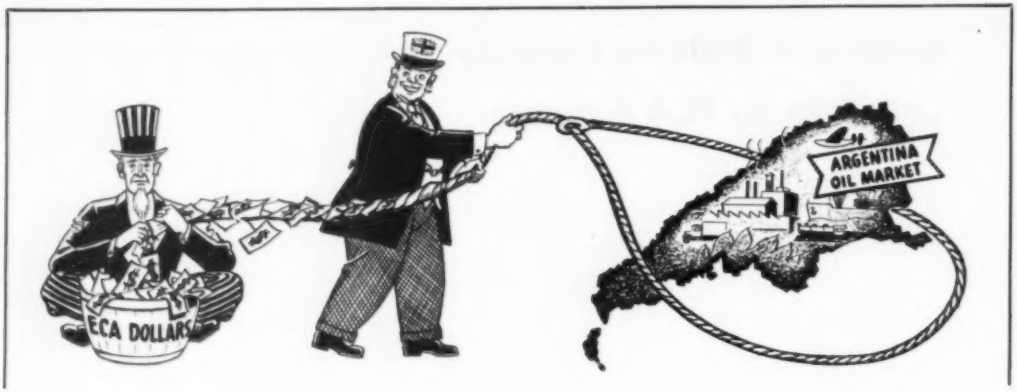
American oil industry is paying the price of Marshall Plan development of competitive facilities in Europe at the rate of $1 billion annually, National Petroleum Council Chairman Walter S. Hallanan declared in an address last month at the annual meeting of the Kentucky Oil & Gas Association.

Hallanan said that while domestic oil production has been reduced 1000 barrels daily, European nations are now capturing markets formerly supplied by American refineries. He cited a recently signed agreement by which Great Britain will supply the oil requirements of Argentina for the next five years. Also he mentioned a long-suppressed report of the Economic Co-operation Administration which revealed plans to increase Britain's refinery capacity to a point eight times its prewar size.

The NPC chairman again called on the oil industry to keep faith with its own declaration of policy, calling for imports only to the extent that they are needed to supplement domestic production. He added, "By no yardstick of economics can there be justification for an import program in excess of the amount necessary to supplement domestic production. By Herculean effort, and at great hazard and capital outlay, the industry has brought domestic supply into balance with all demands. It should not be penalized for this noteworthy achievement."

Great Britain's proposal to increase its domestic refining capacity 800 percent between 1947 and 1953 was discussed by James V. Brown, secretary-treasurer of the National Petroleum Council at the 26th annual meeting of the Pennsylvania Grade Crude Oil Association at Pittsburgh in June.

Brown pointed out that if and when Britain obtains funds to build additional refining capacity, it also will build capacity for lubricants which have accounted for 35 percent by value of all ECA oil provided during a recent six



John Bull Extremely Busy Grabbing World Oil Markets

BRITAIN has taken its first definite step toward the domination of worldwide oil markets and many industry leaders now believe that U. S. oil has forever lost its dominant position in global trade. The trend toward British petroleum supremacy—which has been going on quietly behind the scenes for just 12 months—was given its most important impetus recently when the British government signed an agreement with Argentina to supply that country its oil requirements for the next five years. Similar deals are virtually concluded in other parts of the world, including Scandinavia and Europe.

One year ago, with the launching of Economic Cooperation Administration aid, Britain's sterling oil made its initial bid to win control of existing dollar oil markets. The British petroleum industry and the British government are so intermeshed that, as one company official expresses it: "You can't tell where the British Foreign Office stops and the British oil companies take over." The British petroleum expansion program is being furthered by two basic factors, one political and the other economic: the declared policy of the British government to push to the limit Britain's overseas trade, and the acute dollar shortage that prevails in most countries.

In practically every area of the world today where oil is used, dollars are scarce—too scarce to pay for the purchase of American oil, especially in the face of increasing quantities of sterling oil being made available through the vast British setup in production, refining and marketing activities. Argentina is a significant example of that dilemma.

Britain has agreed to supply Argentina 5,700,000 tons (42 million barrels) of oil a year, of which 1,800,000 tons will be crude. The remainder will be mainly heavy products. In return for this, Argentina will furnish Britain with meat, grain and linseed.

Argentina has been importing about 39 million barrels of petroleum annually. American oil companies have been receiving about $115 million yearly from oil exports to Argentina, and British companies have been deriving $4 million from oil shipments. Most of Argentina's imports have been coming from the Caribbean area, and chiefly from three American companies, Standard Oil Company (N. J.), The Texas Company, and Socony-Vacuum Oil Company, while Shell Oil Company has been the principal British supplier.

Imports 90,000 Barrels Daily

Argentina's oil consumption at present is about 155,000 barrels a day, of which 65,000 barrels daily comes from local production. Thus, the import volume now used runs to about 90,000 barrels a day. Argentina exports a small amount of specialty crudes and products to the U. S. In 1948 these totaled only 1,400,000 barrels of crude and about 670,000 barrels of refined products, mainly lubricating oils.

Both Venezuela and the Middle East will be the source of British oil for fulfillment of the British export quotas to Argentina in the next five years. The refined products will move in from Shell's plant at Curacao.

Other displacement of dollar oil by sterling oil is taking place on the continent of Europe and in Scandinavia. In Sweden, for example, three American companies and two British companies supply Swedish requirements. Until recently the market situation there has been competitive. However, the Swedish government has sharply reduced the amount of dollars available for U. S. oil, and the American firms have been drastically curtailed in their operations. In Denmark and elsewhere American companies are facing the alternative of shrinking their business volume in view of the dollar shortage, or accepting sterling payments in the hope of being able at some future time to convert these into dollars. British companies accept sterling payment and are able, under the Marshall Plan, to convert immediately into dollars.

Supplant U. S. Oil?

Both domestic and foreign industry leaders say it is impossible to predict at this time what proportions this kind of trading may assume. It is generally agreed that if it continues British oil will easily supplant American oil in all the world's centers. In South America, distributors are highly concerned because of U. S. loss in important specialty lines.

ECA assistance to Britain is held at least partly contributory to the huge British expansion move. Britain is depending on Marshall Plan funds to increase by eight times its refining plant capacity, to double its overseas oil production, chiefly in the Middle East and in Venezuela, and to increase by 40 percent its overseas refining capacity.

The key to British oil policy lies in Middle East operations. The increasingly lush prospects for Persian Gulf oil sharply contrasts with other world areas, particularly the U. S., where production cutbacks have been effected. In the Middle East, on the other hand—where 65 percent of all production is sterling oil—output has increased from about 1 million barrels a day one year ago to around 1½ million barrels at the present time. The British-dominated Iraq Petroleum Company plans to step up Iraq production from around 50,000 barrels a day present rate to 125,000 daily this year while Iran's output is now 570,000 barrels a day. Also about three-fourths of the output from Kuwait is sterling oil, as Qatar production will be shortly.

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months' period. He said that ECA's petroleum department is now attempting to work out with Great Britain a solution to this problem which he said looms "rather seriously."

ECA figures indicate, he said, that Marshall Plan countries will receive only 9.3 percent of their crude oil and petroleum products from the U. S. this year, compared with 28.9 percent in 1938, and that such receipts from the U. S. by 1953 are expected to drop to 3.2 percent, while other Marshall Plan countries are predicted by 1953 to receive 77 percent of their oil requirements from the Middle East.

COPPER ALLOY BULLETIN

CONDENSER AND HEAT EXCHANGER TUBING EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

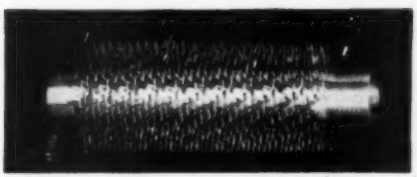
Prepared Each Month by BRIDGEPORT BRASS COMPANY "Bridgeport" *Headquarters for BRASS, BRONZE and COPPER*

Finned Tubing Finds Wider Applications

Improved Heat Transfer Properties Give Greater Economy

Serrated strips, helically wound and soldered or welded to tubes, greatly increase the surface area and thus the heat transfer effectiveness of each foot of tube length. Illustrated is a typical Tilco-Fin Tube, made by David E. Kennedy, Inc., Brooklyn, New York, with Bridgeport copper tubing and copper strip in its fabrication. Excellent corrosion resistance and high thermal conductivity assure good heat transfer properties.

The higher heat transfer properties of finned tubing compared to regular tubing allows for a smaller and more compact coil



Tilco-Fin Tubing Made of Bridgeport copper and copper-base alloys. Courtesy David E. Kennedy, Inc., Brooklyn, N. Y.

design, more economical heat exchanger surface, smaller ducts, higher air speeds, and greater over-all equipment economy.

Petroleum Refinery Applications. All refinery materials such as crude oil, gasoline, naphtha, fuel oil, gas oil, lube oil and reduced crude may be either heated or cooled in a finned tube of a suitable material fabricated by a method suitable to the temperature and pressure of the operation involved. Cooling is carried out in air-cooled heat exchangers by blowing air by means of forced draft over the finned surfaces. Such units are becoming increasingly important in many areas due to short water supply. Heating may be carried out by passing hot flue gases over the finned surface. Considerable "waste heat" may be utilized economically by employing finned tubing.

A very important use of air-cooled heat exchangers is for cooling the jacket water of Diesel engines in power stations, pipe line pumping stations, gas pipe line pumping stations in desert or any water shortage areas. The oil fields now being opened in the Middle East will require considerable amounts of finned tubing for pipe line and power services.

Chemical Processing Applications. The chemical and process industries use finned tubes in drying operations for steam heated ovens, and tunnel driers. It permits compact design, easily controlled equipment temperature, and very economical operation because of high efficiency of the finned surface and low operating temperatures of the coils.

Another class of heat exchange problems for which finned tubes provide an answer involve liquids which have poor heat transfer properties. The heating or cooling of vegetable oils is a good example.

Other Applications. Most any gas or vapor heating or cooling operation can be economically handled on a finned surface. An important use of finned tubes is for hydrogen or air coolers used on turbine generators. For space heaters copper tubes with copper fins have been applied successfully for some time. There are also a few cases where Cupro Nickel tubes and welded steel fins and Cupro Nickel tubes with solder bonded copper fins have been used. The same fin material as the outside surface of the tubing is advocated if welding is required. For solder bonded fins dissimilar metals may be used. For example, a high pressure tube may require steel for strength, a brass liner for corrosion resistance and solder bonded copper fins for high thermal conductivity.

Finned Duplex Tubing Available. For improved heat transfer properties, fins can also be applied to the exterior of Duplex Tubing for handling two entirely different types of corrosion media present on both the inside and outside of the tubing but cannot be handled satisfactorily with a single metal. Combinations, such as Cupro Nickel, Admiralty, Duronze *IV (Aluminum Bronze), Silicon Bronze, Copper, Muntz Metal can be made with steel, stainless, aluminum or monel either inside or outside to handle corrosive fluids or gases such as hot oil, ammonia, and a variety of acid or alkali solutions.

Corrosion Resisting Alloys. A wide variety of materials of construction are available capable of handling practically all liquids and gases no matter how corrosive. For making finned tubing Bridgeport condenser tube alloys, such as Copper, Admiralty, Aluminum Brass, Muntz, Aluminum Bronze, Silicon Bronze and Cupro Nickel are available.

*Reg. U. S. Pat. Off. 2093380

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Mills at Bridgeport, Connecticut, and Indianapolis, Indiana • In Canada: Noranda Copper and Brass Limited, Montreal

Will Old-Man Weather...

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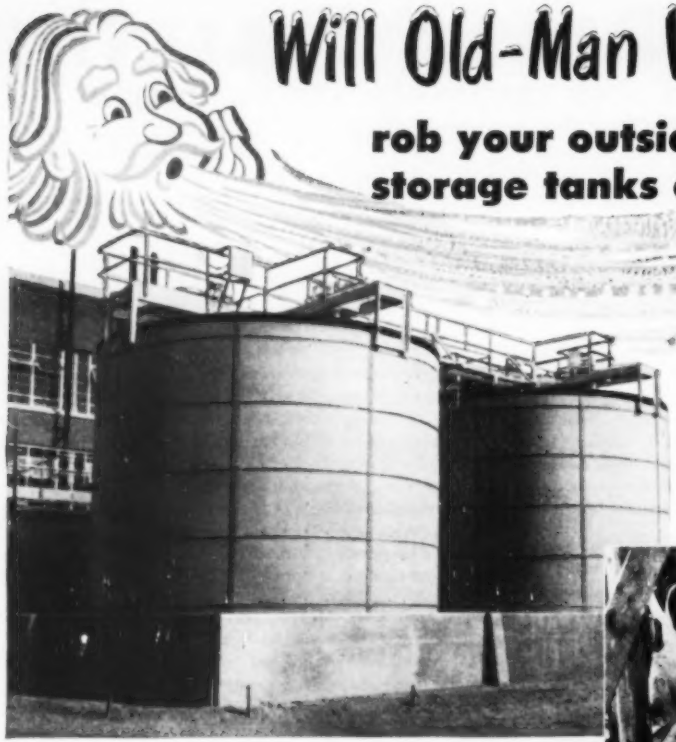

Left: These neat-appearing, insulated tanks are weather-protected by the Johns-Manville specification described here.

Below: Applying J-M Asbestocite (asbestos and cement sheets that are weather- and corrosion-resistant) over standard J-M Insulations.

... Here's how Johns-Manville can help you save fuel costs . . . maintain temperatures of externally stored fuels and chemicals . . .

IF YOU HAVE OUTDOOR tanks and vessels... and are heating or cooling them it will pay you to look into the Johns-Manville Weather-Protected Insulation specification.

Weather-Protected Insulation pays even though outdoor storage tanks are operated at moderate temperatures—because wind and other weather conditions can greatly affect tank temperatures. Savings, for example, on a standard fuel storage tank operating at 130 F maintained temperature can be as much as 200 Btu/sq. ft./hr.

Basically, this Johns-Manville Weather-Protected Insulation specification consists of standard J-M insulations over which is applied Johns-Manville Asbestocite (asbestos-cement sheet) to protect the insulation from the weather. Shielded in this manner, the insulation pays dividends in fuel savings for many years.

If you wish, a Johns-Manville Insulation Engineer will be glad to survey your outdoor equipment to estimate fuel savings for you. Or, for more details send for a copy of folder IN-121A. Johns-Manville, Box 290, New York 16, New York.

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PETROLEUM
REFINER
JULY, 1949

Equilibrium Constants for High Boiling Hydrocarbon Fractions Of Varying Characterization Factors

F. H. POETTMANN and B. J. MAYLAND
Phillips Petroleum Company, Research Department, Bartlesville, Oklahoma

***CURRENT PRACTICE** among engineers engaged in process work usually limits the calculation of vapor-liquid equilibria by algebraic methods using the equilibrium vaporization constants of individual components to about C_{12}, roughly corresponding to fractions having 400° F. endpoint. This includes the gasoline boiling range. Calculations with heavier oils are conducted with flash curves and rather empirical methods.*

Given here are data and a calculation procedure that allows algebraic type calculations to be made with oils having normal boiling points up to 1000° F. Equilibrium vaporization constants based on the boiling points and the characterization factors of individual fractions are used. The procedure is much the same as that presently used for vapor-liquid equilibrium calculations, but the system extends the use of algebraic type calculations far past the limits where calculations with individual hydrocarbon components become hopelessly complicated because of the great number of components that must be handled.

In the opinion of the editors, this article constitutes a valuable design procedure to be added to the working tools of process men generally.

THE engineer frequently has need for equilibrium vaporization constants of high boiling hydrocarbon components and fractions. Experimental data for predicting the phase behavior in mixtures of components having normal boiling points above 200° F. are lacking. The phase behavior can be estimated, however, by various methods available in the literature. For the convenience of the engineer this has been done for fractions having normal boiling points from 300 to 1000° F. and characterization factors from 10.5 to 12.5. A set of charts were prepared covering a range of temperature up to 1000° F. and pressure up to 1000 psia. Reasonably good results can be obtained using the values given on the charts. However, experimental data should be used when available.

The equilibrium vaporization constants were calculated from the expression:

$$K = \frac{y}{x} = \frac{f_L}{f_V} \qquad (1)$$

where:

f_L = Fugacity of the pure component in the liquid phase at the temperature and pressure of the system

f_V = Fugacity of the pure component in the vapor state at the temperature and pressure of the system

y = mole fraction of component in vapor phase

x = mole fraction of component in the liquid phase

K = equilibrium vaporization constant

Various correlations of the fugacity of hydrocarbon vapors by reduced temperatures and pressures have been presented[6, 7, 8, 10]. These fugacities were calculated from the PVT behavior of the pure compounds and were intended, primarily, for use in calculating the thermodynamic properties of the pure compounds. Kirkbride[5] developed an empirical fugacity correlation based upon experimentally determined equilibrium vaporization constants. It is this fugacity correlation Figure 1 which was used in the calculation of the equilibrium constants presented in this paper.

The effect of pressure on the fugacity of a component in the liquid phase was calculated from the equation[10]:

$$\ln f_L = \frac{1}{RT}\int_{P_s}^{P} V\,dP + \ln f_s \qquad (2)$$

where:

f_s = Fugacity of the pure component at the vapor pressure P_s corresponding to the temperature T of the system

V = Molar volume of the component in the liquid phase

R = Gas constant

Assuming that the effect of pressure on the liquid volume is negligible and substituting M/D for V where M is the molecular weight and D the density one can write:

$$\log f_L = \frac{M\,(P - P_s)}{2.303RTD} + \log f_s \qquad (3)$$

The value of P_s at temperatures above the critical temperature of the component can be determined by the extrapolation of the vapor pressure on a Cox chart or other vapor pressure correlation where a straight line extrapolation may be used. The value of the density was taken at 60° F.

Equilibrium constants were then calculated for materials having normal boiling points from 300° F. to 1000° F. and characterization factors of 10.5, 11.5 and 12.5. The characterization factor is defined as the cube root of the absolute boiling point in degree Rankine divided by the specific gravity at 60° F. The characterization factor indicates the general origin and nature of the oil and is introduced here in an attempt to show the effect of molecular constitution on the equilibrium vaporization constant.

Typical values for the characterization factor are as follows[1]:

Pennsylvania stock	12.0 - 12.4
Midcontinent stock	11.8 - 11.9
Gulf Coast stock	11.0 - 11.5
Cracked Gasoline	11.4 - 12.0
Combined feed	10.5 - 11.4
Recycle stock	10.0 - 10.8
Cracked residuums	10.0 - 11.0

The characterization factor of mixtures may be calculated from the characterization factors of the components since they are linearly additive on a weight fraction basis.[1]

From the normal boiling point and the characterization factor all properties necessary to calculate the equilibrium constants such as critical temperature, molecular weight and gravity were determined from a correlation by Watson and co-workers[4] Figure 2. The critical pressure was then determined from the critical temperature and a Cox or other straight

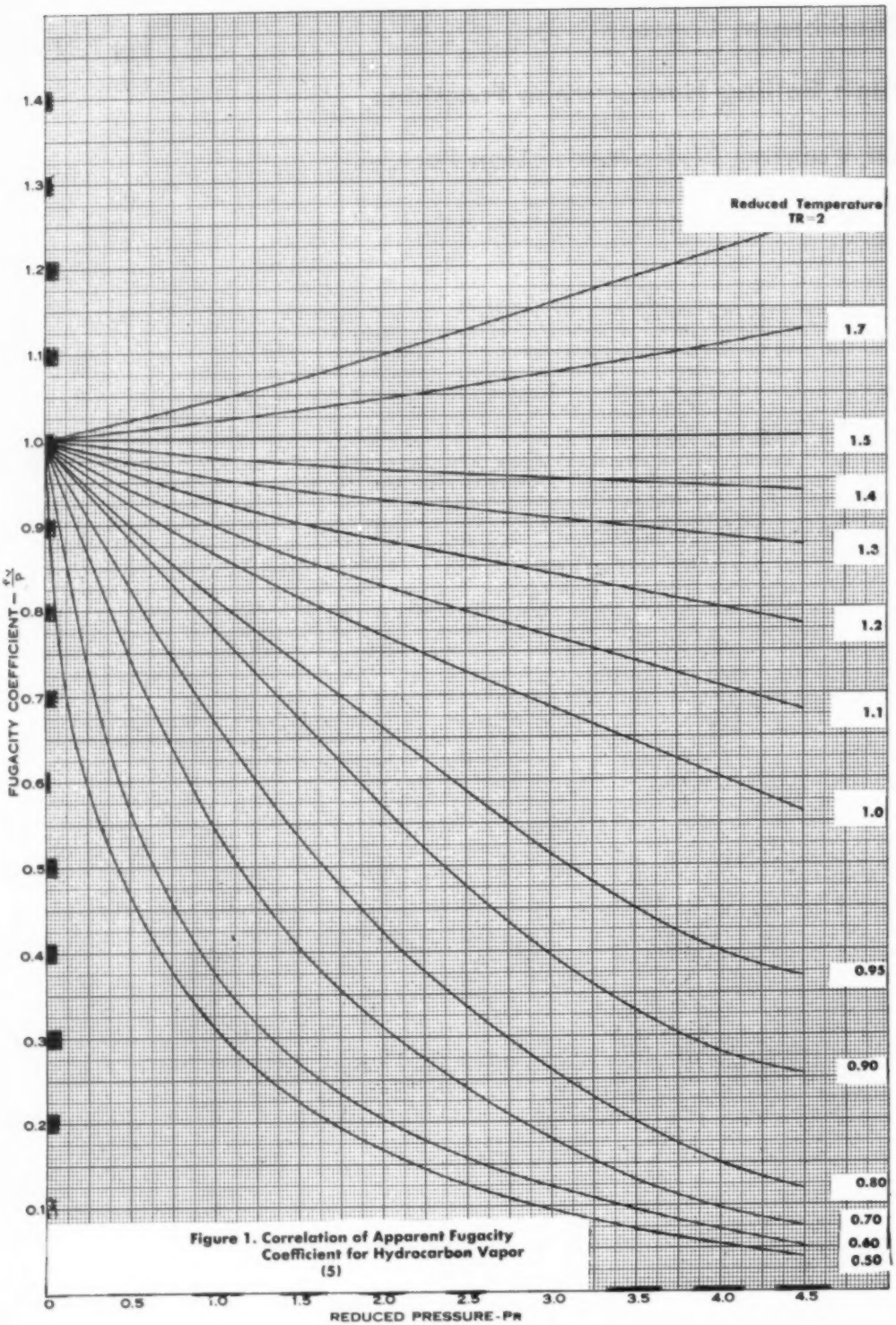

Figure 1. Correlation of Apparent Fugacity Coefficient for Hydrocarbon Vapor (5)

line vapor pressure correlation.

Isotherms of equilibrium constants for various normal boiling points and given characterization factors were first calculated. These were then cross plotted as the log of the equilibrium constants versus normal boiling point for lines of constant temperature and pressure. From these plots, charts of the log of the equilibrium constant vs. temperature for a given characterization factor and normal boiling point were prepared. These diagrams then served as a basis from which the final charts were prepared, Figures 3 to 10. Cross plotting the charts in this manner made certain that the finished charts were consistent with one another.

Use of Charts

Various applications of these charts will be demonstrated such as 1) the calculation of equilibrium vaporization constants for C_7 plus fractions, 2) determination of the equilibrium constants for pure high boiling compounds such as dodecane and others, and 3) calculation of the equilibrium flash curve from the true boiling point curves of distillates and crudes.

Problem

(1) Calculate the equilibrium vaporization constant for a C_7 plus fraction at 675 psia. and at a temperature of 200° F. The specific gravity of the C_7 plus fraction is 0.7905 at 60/60 (47.5 API) and its molecular weight is 145.5.

Solution

From the specific gravity and molecular weight and Figure 2, the characterization factor of this fraction is found to be 11.8 and its normal boiling point is found to be 350° F. By plotting the log of the K values of 675 psia. and 200° F. from Figures 3, 4, and 5, for a material having a characterization factor of 11.8 against the normal boiling points the value of K for this C_7 plus fraction was found at the normal boiling point of 350° F. to be 0.0096.

Problem

(2) Calculate the equilibrium vaporization constant for dodecane at 500° F. and 50 psia. The boiling point of dodecane is 421.3° F. and its density is 0.7520 grams per cc. at 60° F.

Solution

$$\text{Characterization factor } \frac{\sqrt[3]{\text{NBP}}}{\text{Sp. Gr.}} = \frac{\sqrt[3]{421.3 + 460}}{0.7520} = \frac{\sqrt[3]{881.3}}{0.7520} = 12.8$$

By following the same procedure as in problem 1, that is, plotting log K at 500° F. and 50 psia. versus normal boiling point for a characterization factor of 12.8, the value of K for dodecane was found at the normal boiling point of 421.3° F. to be 0.66.

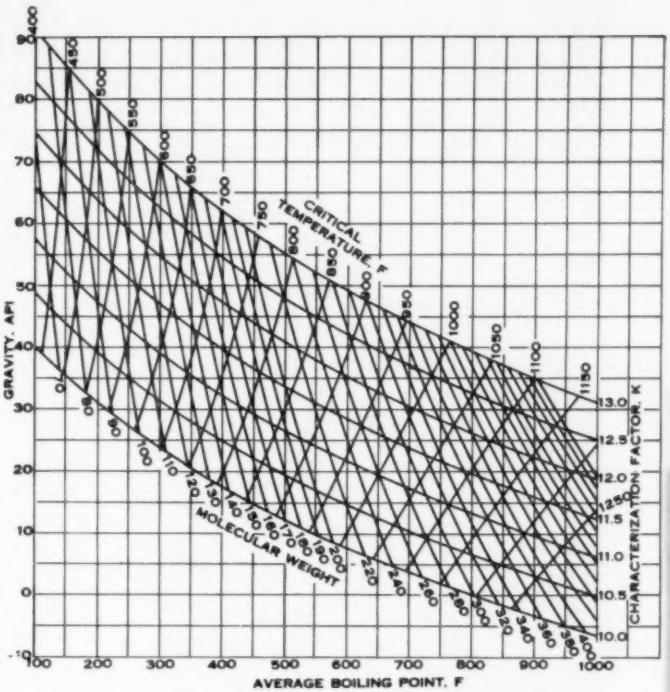

Figure 2. Molecular Weights, Critical Temperatures and Characterization Factors of Petroleum Fractions. (4)

Problem

(3) Calculate the equilibrium flash curve at atmospheric pressure for a weathered Erath distillate knowing the true boiling point curve, Figure 11, and the mid-boiling point versus density and molecular weight curves Figure 12. (9)

Solution

Since at atmospheric pressure the K values for all characterization factors for a given boiling point are the same, there is no need to determine the characterization factor of the distillate. The true boiling point curve was divided into fractions having mid-boiling points of 200, 300, 400 and 500° F. and one fraction of 600 plus. A butane, pentane and hexane fractions were also estimated. From the mid-boiling point curves of density and molecular weight the composition of the distillate in terms of mole fractions was calculated as follows:

Component	mole fraction
C_4	0.0162
C_5	0.0185
C_6	0.0293
NBP-200	0.2795
300	0.2100
400	0.1970
500	0.1580
600+	0.0915
	1.0000

The analysis as given here appears different than that given in the article from which this data were taken because of the fact that different boiling ranges or mid-boiling points were taken to describe its composition.

The bubble point and dew point temperature of this material are then calculated from the relationship.

$$y_i = K_i x_i$$

This then determines the zero per cent point (227° F.) and the 100 per cent point (470° F.) of the flash curve.

The flash equation is then used to determine points between zero and 100

■ TEXT CONTINUED ON PAGE 112
NOTE INTERVENING EIGHT FIGURES

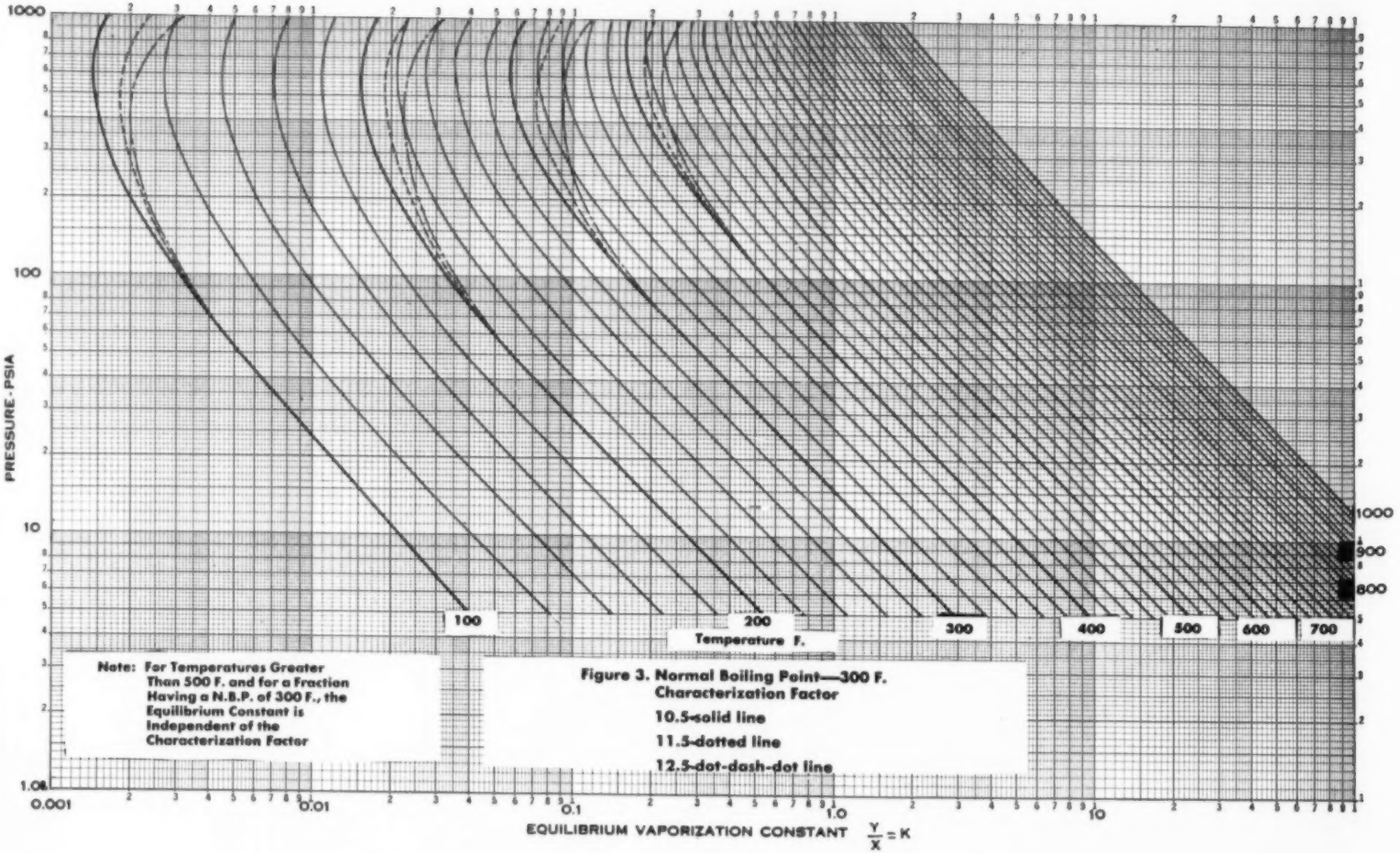

Figure 3. Normal Boiling Point—300 F.
Characterization Factor
10.5-solid line
11.5-dotted line
12.5-dot-dash-dot line

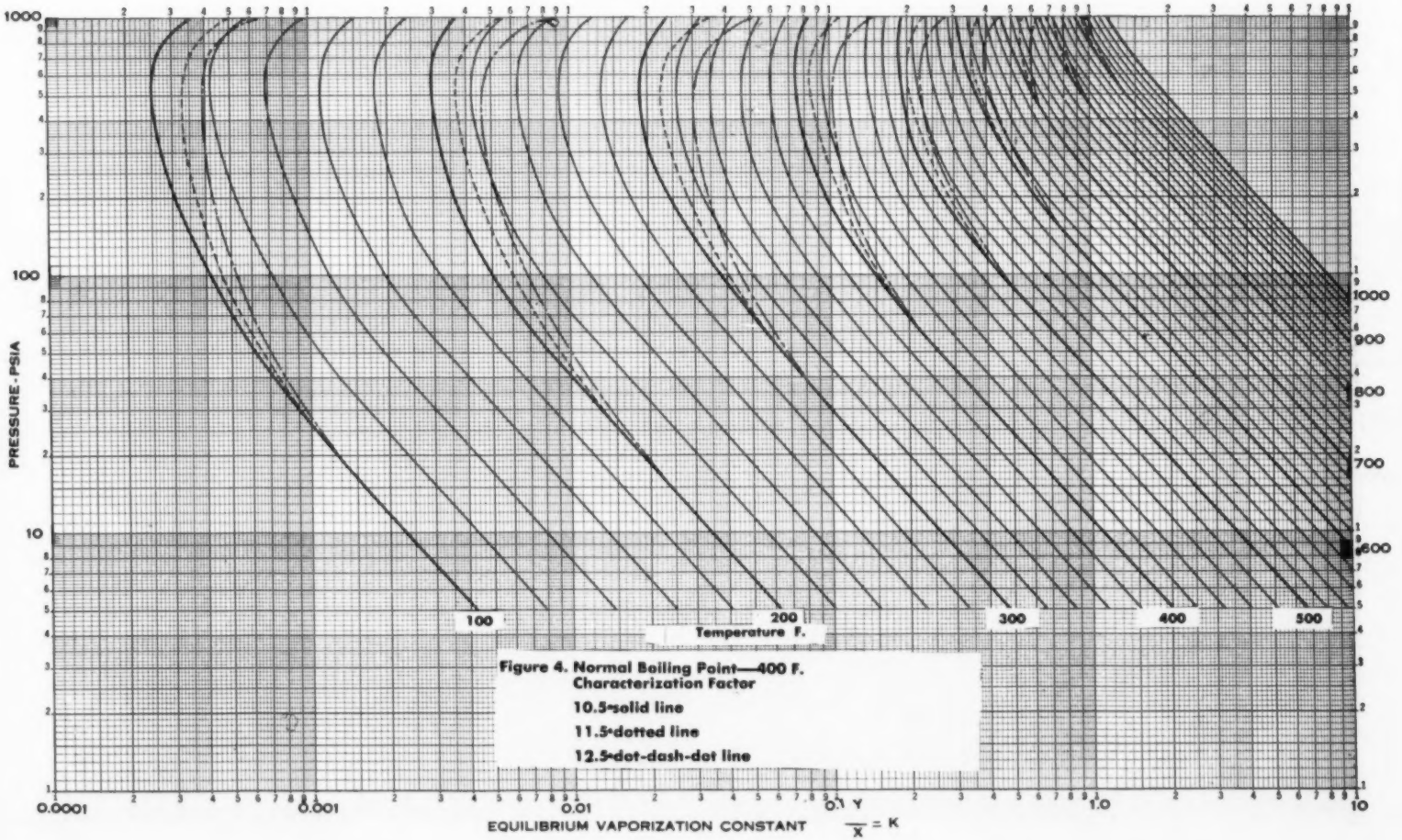

Figure 4. Normal Boiling Point—400 F. Characterization Factor

10.5-solid line

11.5-dotted line

12.5-dot-dash-dot line

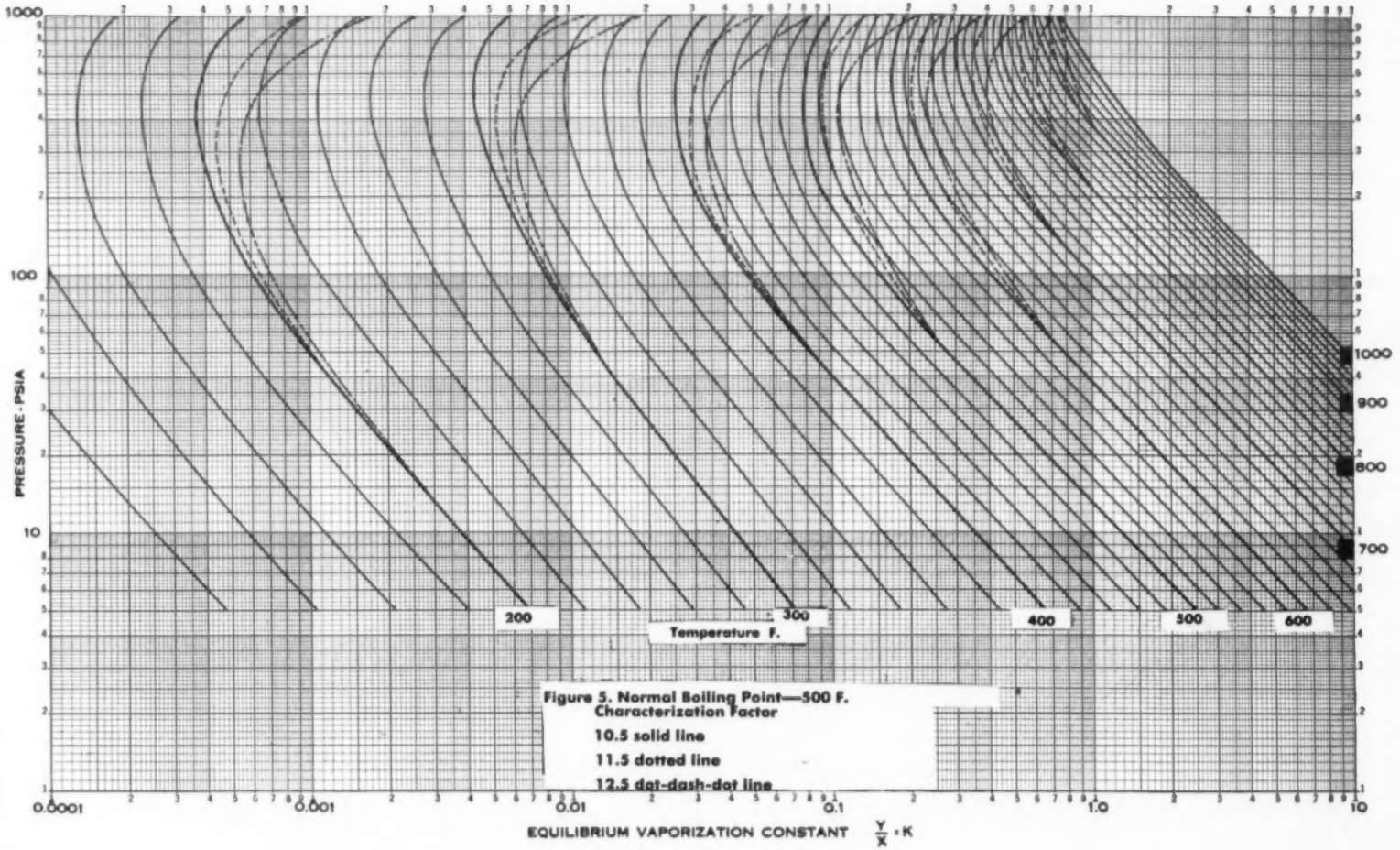

Figure 5. Normal Boiling Point—500 F.
Characterization Factor
10.5 solid line
11.5 dotted line
12.5 dot-dash-dot line

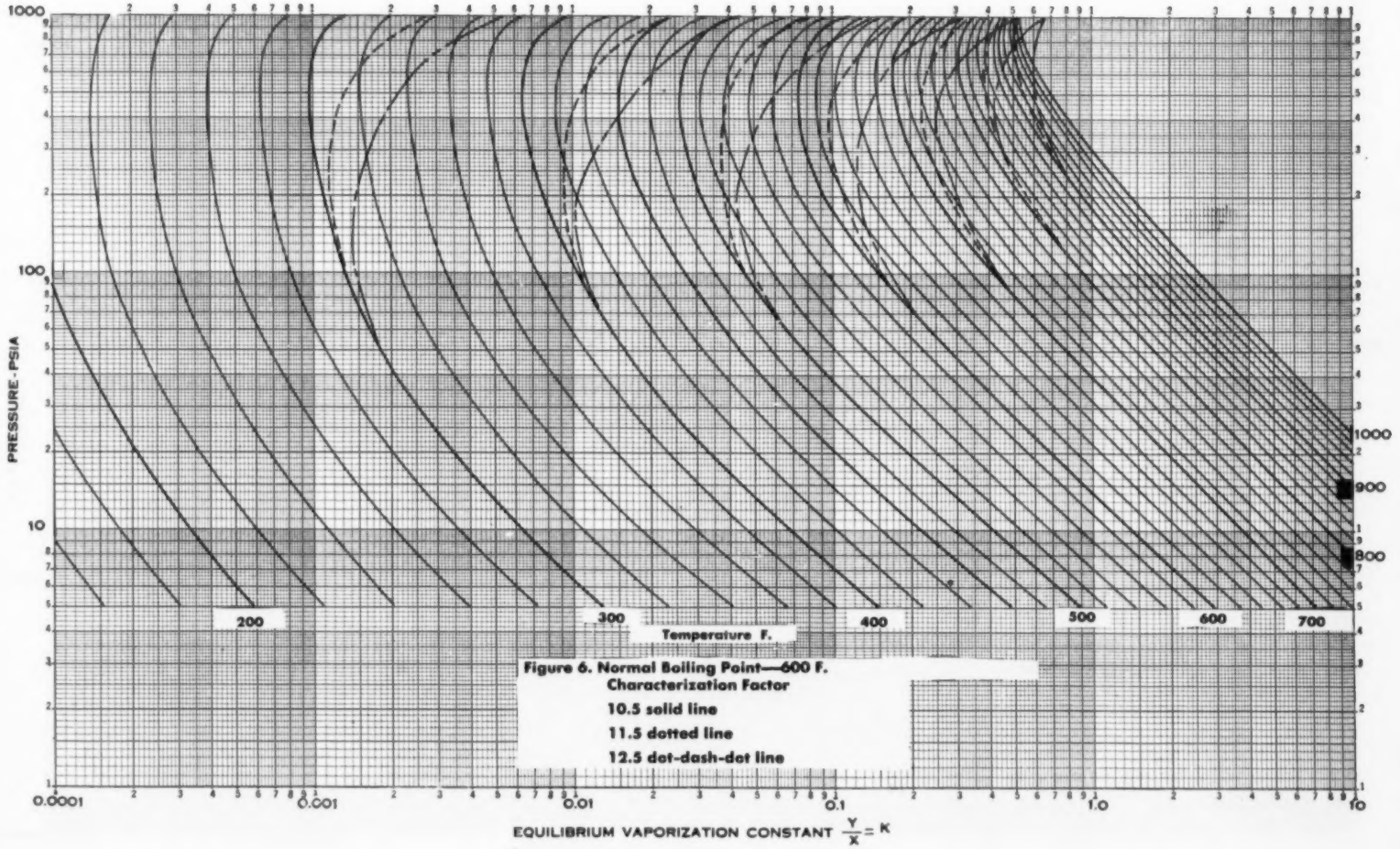

Figure 6. Normal Boiling Point—600 F. Characterization Factor

10.5 solid line

11.5 dotted line

12.5 dot-dash-dot line

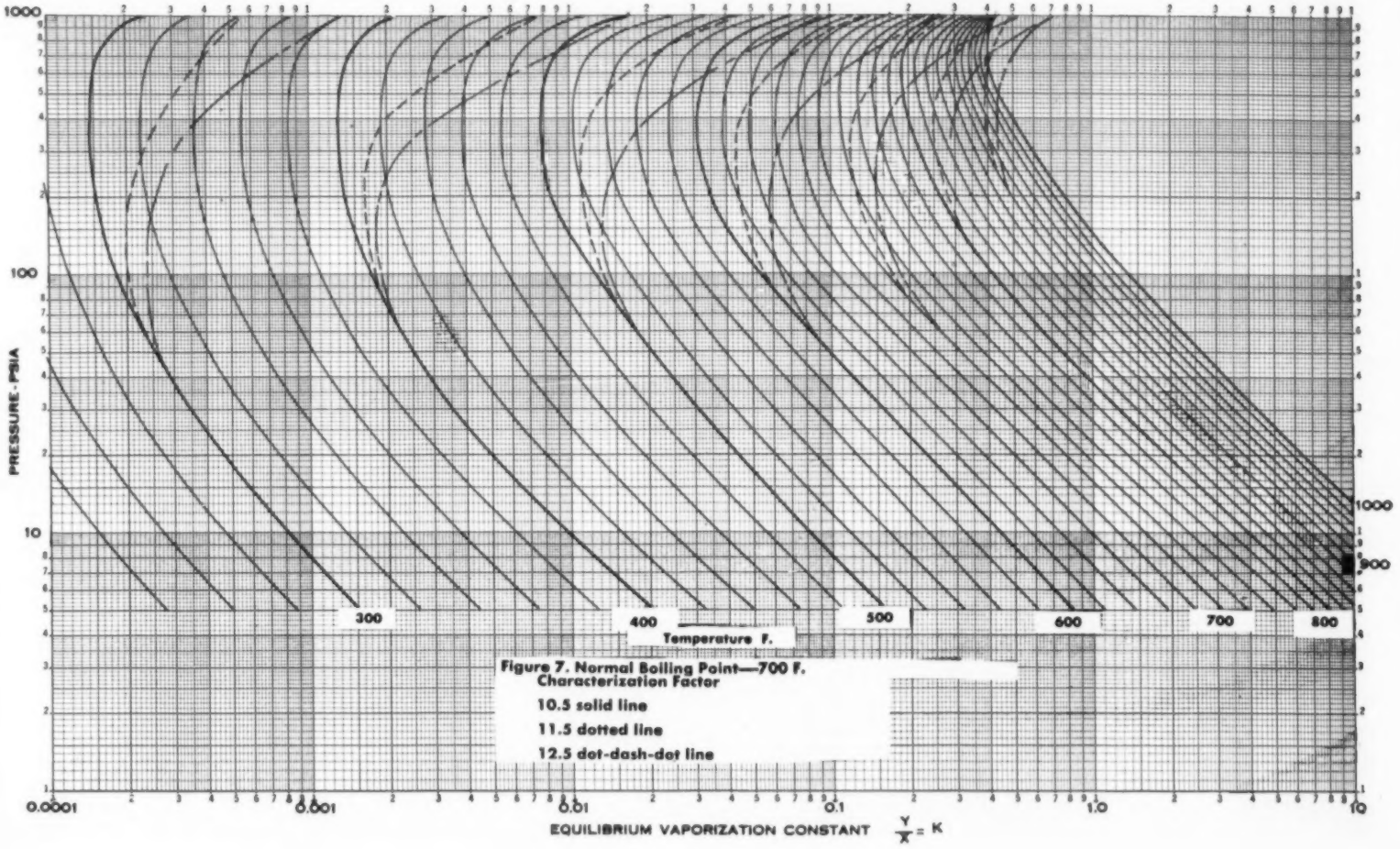

Figure 7. Normal Boiling Point—700 F. Characterization Factor

10.5 solid line

11.5 dotted line

12.5 dot-dash-dot line

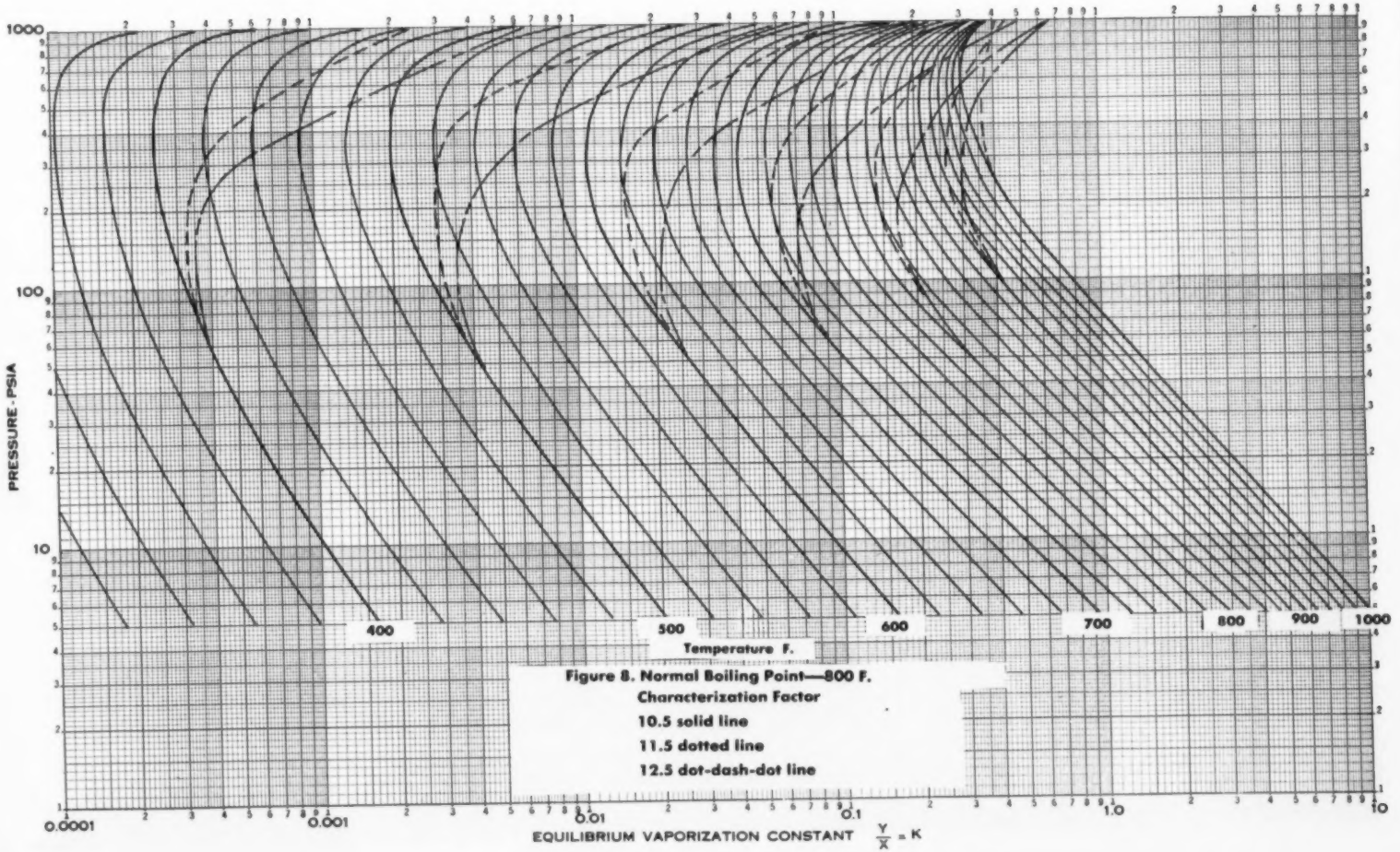

Figure 8. Normal Boiling Point—800 F.
Characterization Factor
10.5 solid line
11.5 dotted line
12.5 dot-dash-dot line

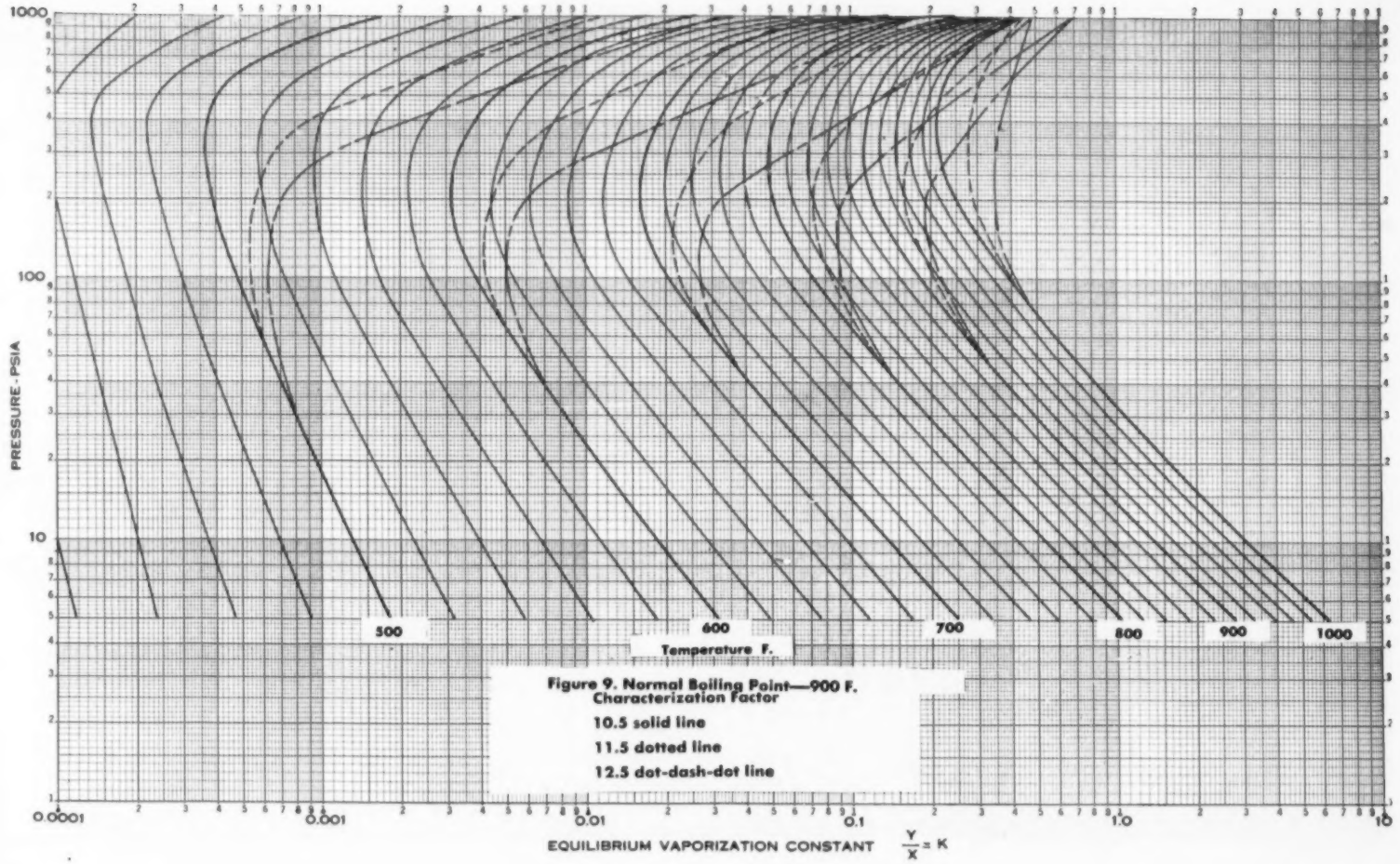

Figure 9. Normal Boiling Point—900 F.
Characterization Factor

10.5 solid line

11.5 dotted line

12.5 dot-dash-dot line

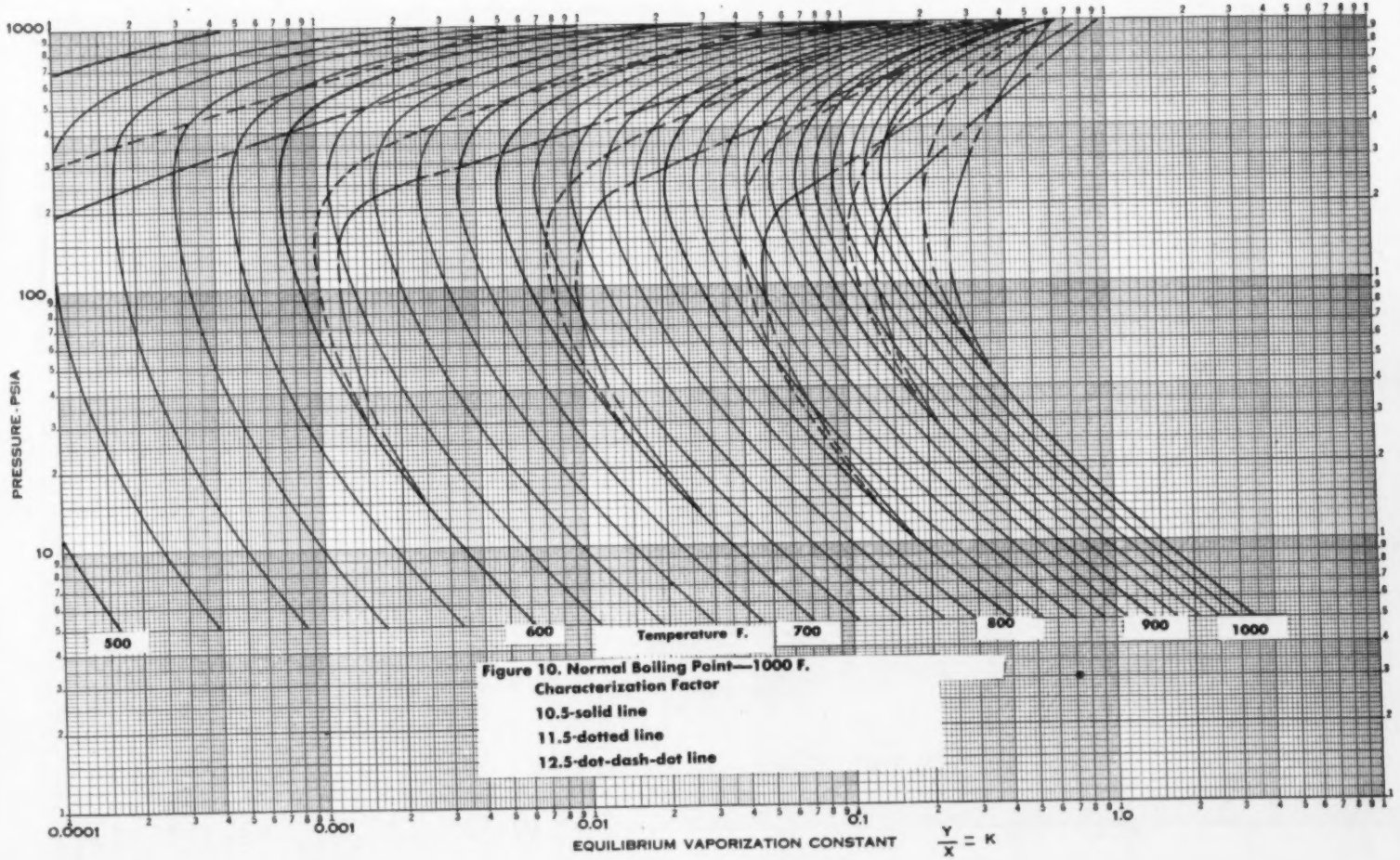

Figure 10. Normal Boiling Point—1000 F.
Characterization Factor
10.5-solid line
11.5-dotted line
12.5-dot-dash-dot line

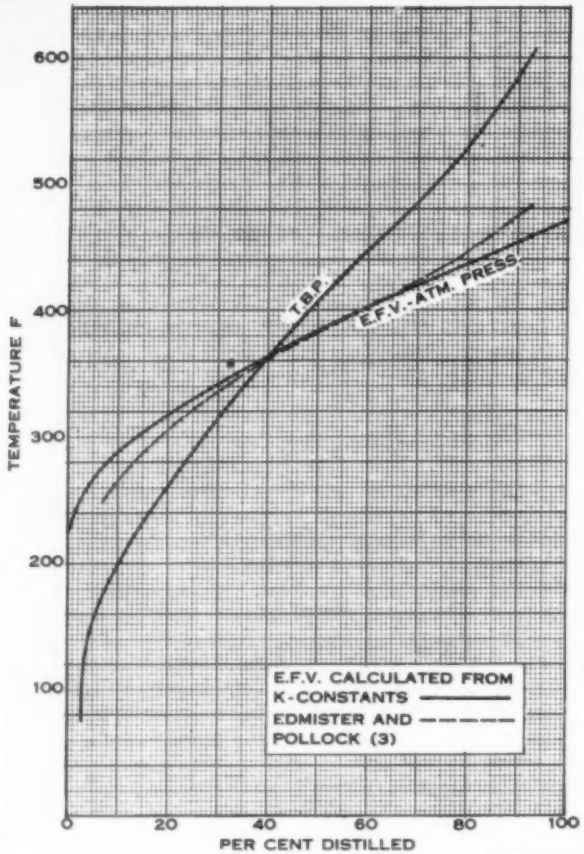

Figure 11 (Above)

• TEXT CONTINUED FROM PAGE 103

percent vaporized.

$$\sum x_i = \sum \frac{x_{ci}}{1 + V(K_i - 1)}$$

The equilibrium vaporization constants for the normal boiling fractions can be obtained directly from Figures 3 to 10. The K constants for butane, pentane and hexane were obtained from Brown's[2] idealized K charts. The K constant for a normal boiling point of 200° F. was determined by plotting the log of the constants at a given temperature and pressure vs. normal boiling point. When plotted in this manner a smooth curve could be drawn through both Brown's K's[2] and those from Figures 3 to 10.

Since the results of the flash calculations are in mole fractions of liquid residue they must be converted into volume of liquid remaining behind, by first multiplying the mole fractions of the components by their respective molecular weights and then dividing by their respective density to obtain volume, the volume of the components are then added to obtain the volume of one mole of liquid, this then is multiplied by the mole fraction of total liquid residue to obtain the volume of liquid remaining behind, knowing this volume, and the original volume, the per cent distilled or flashed over can be calculated.

Figure 11, shows the resulting flash curve calculated from the equilibrium constants as compared to a curve determined by a recent empirical correlation of Edmister and Pollock[3]. The agreement is good. In addition, use of the equilibrium constants for calculating flash curves gives the true boiling curves of the liquid residues and vapors directly from the calculations.

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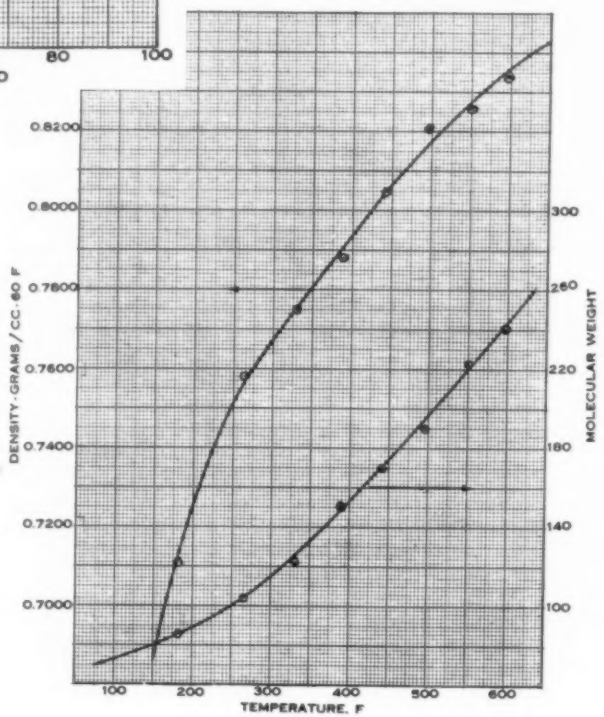
Figure 12 (Below). Mid-Boiling Point vs. Density-Molecular Weight. (9)



Startup Procedure For a Natural Gasoline Plant

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Oil exchangers and chillers in the foreground of this picture made at the Dubach gasoline plant recently completed near Dubach, La., 11 miles north of Ruston, by Southwest Gas Producing Company, Inc., and W. C. Feazel, Shreveport. Reabsorbers and high-pressure absorbers in background.

THE increasing complexity of natural gasoline extraction plants, due to the demand for higher propane recovery, has resulted in a need for greater knowledge among plant operating personnel. By analyzing the initial startup procedure of a representative plant, it is the purpose of this article to give the actual operator a better understanding of each individual piece of process equipment in simple and non-technical language. Since every absorption-type gasoline plant employs the same basic principles of design, there is no need to select any particular plant, rather, base this discussion on a hypothetical plant of typical present day process design.

WHEN Tom Tabbert, co-author with Curt Ames of the article "Ethane and Propane Separation Greatly Simplified" at Dubach, La., May, 1949, Petroleum Refiner, was explaining details of the plant preparatory to writing the story, the talk turned to plant operation. Originally, Tabbert planned to expand this discussion into an operators' guide for this particular plant. After further consideration, however, he concluded that the operating discussion would apply equally well to most gasoline plants. Thus, the present article is the final result. It is intended for, and should be of interest to, the operators in many gasoline plants.

A natural gasoline plant of the absorption type is a plant that extracts the valuable components from a natural gas by means of a stable oil stream. The natural gas entering the plant will consist of a mixture of methane, ethane, propane butane and a gasoline fraction. These components are listed in order of weight and boiling point. Thus, methane is the lightest and lowest boiling point constituent, while the gasoline fraction is the heaviest and highest boiling point constituent. From a gasoline plant standpoint, the propane, butanes and gasoline are the valuable constituents to be recovered, while the methane and ethane are the undiserable components to be eliminated in the residue gas streams.

Actually, any absorption plant can be divided into four basic process sections: the primary absorbers, the stripping units, the vent vapor recovery system and the fractionation section. The following discussion of a normal startup will be based on these four classifications. It is hoped, in turn, that operators will be able to classify the process equipment in individual plants into these primary divisions to understand fully the fundamental process principles described.

All plants have available some emergency fuel gas which is provided by the incoming rich field gas. By utilizing this gas it is possible and necessary to have the utilities well broken in before facing the actual process unit startup. Brevity requires that this paper assume that the steam, cooling water, fuel gas, electricity and instrument air are in operation and ready for plant load. It will also be assumed that the plant has been hydrostatically tested and purged of air by blowing the rich field gas through all the units.

Pressures Established

It is the simplest system in placing a plant on stream to establish the pressures on all of the vessels excluding the fractionation plant. By bleeding a small amount of gas from the main absorber, the various pressure regulators on the flash tanks, reabsorber, still, etc. can be set to hold each vessel at operating pressure. Since oil circulation depends on pressure forcing the oil through a large part of any plant,

setting these regulators in advance assures oil flow through the plant. This can be done while the absorption oil is being initially charged into the plant with the makeup oil pump. Since the capacity of this pump is small with respect to the capacity of the entire system, considerable time is available.

When sufficient oil has been pumped into the plant to fill all the vessels, the lean oil circulating pumps can be placed in operation. If it is not necessary to flow gas through the absorbers, this can well be omitted until the oil circulation is established. By holding static gas pressure or maintaining minimum gas flow on the main absorbers, sufficient gas will be absorbed by the oil to maintain pressure on the various gas regulators that have been previously set. This will maintain a smooth flow of oil through the plant.

When oil circulation has been fully established, and level controls adjusted, heat can be applied to the still preheater. Heat will be furnished by steam or a direct-fired heater. At the same time cooling water can be circulated through the oil coolers. The plant has now been readied for admittance of the rich natural gas flow through the main absorbers. By spending a little additonal time in establishing the oil flow, setting the key gas regulators, and bringing the oil up to operating temperature, much of the general confusion surrounding plant startups can be eliminated.

Flow of Gas Started

The flow of gas through the main absorbers can now begin. Rich gas enters the column at the bottom, flowing upward through the bubble trays countercurrent to the lean absorption oil flow. Oil flowing down the column absorbs selectively constituents from the rich gas. The oil absorbs a higher percentage of the heavier constituents but also absorbs considerable quantities of undesirable methane and ethane. For example, a high pressure absorber designed to recover 75 percent of the propane will absorb 100 percent of all the heavier components, butane and gasoline, but will also absorb approximately 25 percent of the ethane and 5 percent of the methane in the inlet rich gas. Since the methane and ethane compose the major portion of the inlet gas, the rich oil leaving the absorber contains a high percentage of these undesirable constituents.

No special precaution need be taken in starting the main absorber except to introduce the gas flow gradually since sudden gas injection might tend to flood the column. The introduction of the gas will cause a rise in temperature of the oil leaving the absorber due to the heat evolved in absorbing the gas. It is important within reason to carry the oil temperature as low as possible since the absorption increases with colder temperature. For extremely rich gas where the temperature rise of the oil becomes excessive, the use of intercoolers part way down the column is necessary and would also be placed in service at this time.

The rich oil leaving the absorber containing not only the desirable constituents, but also undesirable ethane and methane, is in equilibrium at the absorber pressure and oil temperature. Any reduction in pressure or increase in temperature tends to free the oil of the absorbed constituents. In a typical plant with a high-pressure absorber, the oil leaving the absorber will be flashed at a lower pressure in the first of one or more vent tanks. Reduction in pressure allows the gas to escape from the oil. In any flash the lighter or lower boiling point constituent escapes in the greatest percentage.

Advantage is taken of this to stabilize partly the rich oil by venting. By a series of cold vents a major portion of the methane, considerable ethane, and small portions of the propane and heavier constituents are removed from the oil. While the vapors leaving the cold vents will be largly methane and ethane, there are usually sufficient quantities of the heavier components to necessitate their being reprocessed in the reabsorbers. These cold flashes of the oil constitute the first portion of the vent vapor recovery system, the purpose of which is to rid the plant of methane and ethane and still retain the valuable components. Since the regulators holding pressure on these vent tanks have been set previously, the pressures will automatically be maintained at the correct operating point.

The partly stabilized rich oil now flows through the oil to oil exchangers and then through the still preheater into the still or stripping unit. As the oil leaving the last cold flash is in equilibrium at that temperature and pressure, the addition of heat causes a large amount of gas to leave the oil. The oil entering the still in the middle of the column is actually a two-phase mixture of gas and liquid; the liquid flowing down the column, the gas rising into the top trays. In this case the temperature is high enough to cause a considerable amount of oil to flash off as vapor even though the liquid retains small percentages of all the absorbed constituents. The top trays above the feed are for the purpose of condensing these oil vapors that rise in the column, while the trays below the feed are required to strip the oil of the remaining absorbed constituents.

Stripping is the reverse of absorption, the higher the temperature and the lower the pressure, the greater the tendency of the absorbed constituents to leave the oil. Further, the lighter the constituent the easier the stripping problem. It is relatively a simple process to strip propane from an oil stream, much more difficult to strip the gasoline fraction. Since stripping all of the components from the oil with heat only would require excessive temperatures, open steam is introduced below the bottom stripping tray. By so doing the partial vapor pressure or the boiling point of each constituent in the liquid is reduced, increasing the escaping tendency of each. The addition of too much steam merely strips more and more oil adding to the load in the trays above the feed and is to be avoided.

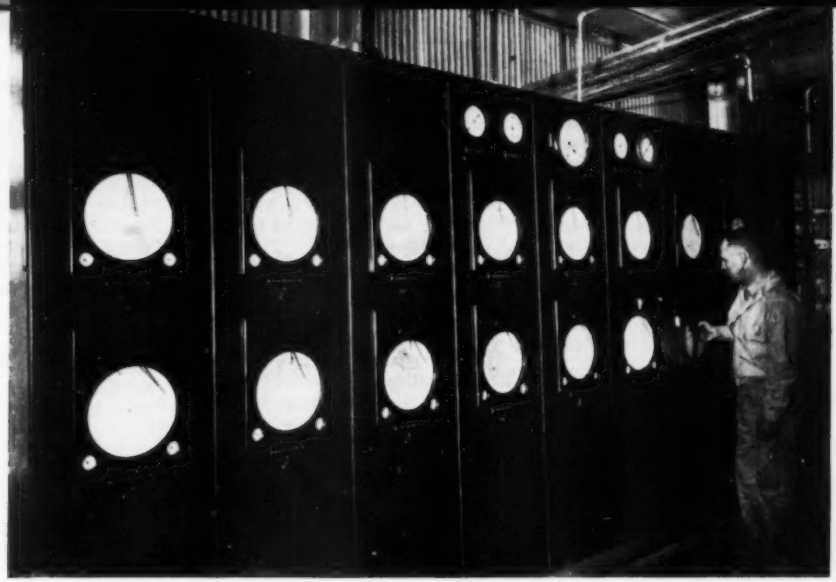
When the oil containing the absorbed constitutents leaves the preheater at full operating temperature, the operator can start the stripping steam flow into the still. All of the vapor flashed in the oil preheater, the stripping steam and the vapor stripped in the bottom trays flow out of the top of the tower. This initial overhead vapor will contain all of the oil vapor that was flashed in the preheater and stripped from the oil. It is common practice in large plants to use a separate reflux condenser and accumulator operating at a temperature low enough only to obtain reflux. The net still overhead liquid and vapor stream from the reflux accumulator flows through a final condenser, where minimum temperature is obtained, and then into the final raw storage tank.

Separate Reflux and Final Condensers

Since the large reflux heat load is removed at a higher temperature level, considerable heat exchange surface is saved. This system of separate reflux and final condensers will be used for the typical plant under discussion. Full cooling water circulation should now be maintained over the reflux condensers to prevent any oil vapors from passing on into the final raw storage tank. The initial liquid that accumulates in the reflux accumulator will contain substantially all of the oil that was in the overhead vapor. Pumping back over the top of the tower should begin before this high end point liquid can flow into the final raw storage tank.

Stills are generally top-temperature controlled at some design temperature high enough to allow the absorbed constitutents to pass on overhead as vapor and low enough to condense the lean oil in the top trays of the column. Re-

"As practical experience of operation is so often neglected in the training of technical personnel, so has the basic process knowledge been overlooked in the training of field personnel." Photo shows fractionating plant instrument board.



flux can be regarded as a method of heat removal. Liquid pumped back over the top of the tower will be vaporized by the heat of the rising vapors and in so doing cool the rising vapor stream. When the still reflux pump is put in service, insufficient liquid will be available to bring the top temperature to the control temperature immediately. It will be necessary to control this reflux manually, pumping back at the rate of accumulation. When the top temperature is near the control point, the pump is placed on control. Reflux for the still will finally be free of oil and attain a constant composition of equilibrium at the still reflux condenser temperature and pressure.

The still is then in complete operation except for checking the performance of the water drawoff legs. These drawoff legs are for the purpose of removing the water that is formed in the top trays when a portion of the stripping steam is condensed at the colder top temperature. To insure proper fractionation in the top trays and prevent water returning to the stripped oil, water must be withdrawn from the trays continuously. The level controls on these drawoffs can be set before the column is started and should go into service automatically.

Previously it has been assumed that a single still is being put into service. Actually the use of a single still in a high-propane recovery plant is unusual. To understand the reason for more than one still, it is necessary to analyze what determines the operating pressure of the stripping unit. A definite quantity of propane is required in the liquid phase in the final raw gasoline product accumulator. For the present the mixed stream of vapor and liquid leaving the still reflux accumulator and flowing through the final cooler into this raw product accumulator will consist of all of the constituents that were absorbed in the main absorber minus the quantities that were withdrawn in the cold vents described previously.

Depending on the efficiency of the cold vents, this stream then will consist of small amounts of methane, considerable ethane, propane, butane and substantially all of the gasoline. Condensation, or the amount of liquid that can be obtained, depends on temperature, pressure, and composition. With the composition set and the minimum temperature limited by cooling water, the variable remaining is pressure. The pressure must be high enough to condense the percentage of propane required in the liquid. For the type plant under discussion this would range in pressure from 150 to 200 pounds. In order to operate a single still at this relatively high pressure range and strip the oil completely through the gasoline fraction, the quantity of high-pressure stripping steam could easily be excessive.

Two Stills in Series

Several alternatives to the use of one still are possible, the most common of which is the use of two stills operating in series. The high-prssure still, operating at the pressure required to obtain the necessary condensation of propane in the final accumulator might strip the oil of all the light constituents—methane, ethane and propane. A second still operating at a low pressure of 50 pounds or less would be charged with the partly stripped oil from the first high-pressure still.

Here a small quantity of low-pressure or exhaust steam would be used to strip the remaining absorbed constituents. Operating pressure of the low-pressure still would be carried sufficiently high to totally condense the butane and gasoline vapors leaving the still overhead. This overhead liquid could then be pumped to the final high-pressure still condenser and combined with the methane, ethane and propane removed in the high pressure still. Thus, the final product would be identical to that obtained with a single still. The procedure for placing two stills in operation does not differ from a single still and need not be discussed further.

Plant operation has proceeded through the main absorber, the cold vent flashes, and the stripping units, and the first raw product is accumulating in the final raw storage tank. While a desired quantity of propane is required in the liquid condensing in this vessel, the non-condensed vapors contain a considerable portion of propane and butane that must be recovered. Considering this partial condensation, it is noted that the heavier constituents do condense in the greatest percentage. For example, condensing 95 percent of the entering butane would result in 5 percent of the methane condensing.

However, this incoming stream contains a small percentage of methane and a high percentage of butane so that actually as much butane could be present in this vapor as methane. The vapor stream leaving would then be extremely high in propane and butane content, and must be reprocessed. There are now two streams of vapors that must be handled in the vent vapor recovery system; this extremely rich stream leaving the final accumulating tank above, and the lean gas that was

vented from the cold rich oil flashes.

In placing the plant in operation it is not advisable to reprocess these streams until operation has proceeded as above. Ordinarily this gas flows directly into a reabsorber or is handled by a recompressor and recycled through a higher pressure reabsorber or even the main absorber. By withholding oil circulation from the reabsorber or not starting the recompressor the vapors will be automatically disposed of without interrupting the startup of the units requiring first attention.

Since the most common recovery system is a reabsorber, this typical plant will combine all the gas vents through one such unit. The reabsorber would normally operate at a pressure slightly below the still pressure so that the non-condensed vapor from the final accumulator would flow to the column without the use of a recompressor. This would also set the design pressure of the cold oil flashes, the lowest flash pressure allowing the gas to flow directly to the reabsorber. If the high-pressure still was operating in the 150 to 200-pound range, the reabsorber would operate at a pressure five or ten pounds less, or 140 to 190-pound range.

Principle of Reabsorber

The principle of a reabsorber is the same as discussed for the main absorber so that the startup proceeds in the identical manner. As the gas is flowing through the unit, the lean oil stream can be admitted over the top of the column and the absorption begins. In the case of a reabsorber the stream of inlet gas from the combined vent streams will have a high percentage of propane and butane in comparison to that occuring in the inlet gas to the main absorbers.

While again undesirable, methane and ethane will be absorbed, the percentage of these constituents in the incoming gas is now much lower. The quantity of methane and ethane leaving in the bottom rich oil will be proportionately low. Operating in this pressure range a much lower percentage of methane and ethane is absorbed for the same percentage propane or butane recovery as that employed for the main absorbers operating at a higher pressure.

The rich oil from the reabsorber will be pumped, as soon as the level is obtained, into the oil to oil exchangers combining with the partly stabilized main rich oil stream from the final cold vent tank. This increases the vapor leaving the still overhead and entering the final raw storage by the amount that was absorbed in the reabsorber. Now the condensation in the final condenser will be relatively the same percentage, but additional propane and butane will be obtained in the liquid phase due to the greater quantity of inlet. This cycle will continue until, with a fixed oil rate over the reabsorber, a constant composition of vapor will be obtained leaving the final accumulator.

Now that the first three sections of the plant are in operation, a considerable amount of product will have accumulated in the fractionation plant feed surge tank. This product will be the so-called raw gasoline, which will normally consist of traces of methane, considerable ethane, propane, butane and all of the gasoline fraction that the gas contained. The fractionation plant is now ready to be put on stream.

Fractionation is roughly defined as the separation of a mixture. In gasoline plants, however, fractionation is considered as that section of the plant that performs the service of making precision separations of the raw gasoline product outlined above. With present market conditions, the usual products desired will be propane, mixed butanes and a constant vapor pressure gasoline. To make this separation a representative plant will include a deethanizer, depropanizer and debutanizer operating in series. The deethanizer will take the raw gasoline charge and eliminate the methane and ethane as the overhead product. The depropanizer will be charged with the bottom product of the deethanizer and separate the propane as the overhead product. Finally the debutanizer will be charged with the bottom product of the depropanizer, where specification vapor pressure gasoline product will be separated as the bottom product with the remaining mixed butanes passing out as the overhead product.

In analyzing these separations it will be noted that the lighter or lower boiling point constituents are removed as the overhead products while the heavier or higher boiling point constituents remain as the bottom product. For a simple explanation of what is occurring within a fractionating column to make a desired separation, consider the trays above the feed as an absorber and the trays below the feed as a stripper. Reflux pumped back over the top of the column tends to absorb the heavier constituents rising into the top trays. Unlike an oil absorber, however, the reflux is very similar in composition to the rising vapors so that when the heavier constituents are absorbed part of the original reflux is vaporized. Thus, the reflux flowing down the trays becomes heavier, while the vapors rising from each tray become lighter until the vapor leaving the top tray is free of the undesired heavy constituents.

The stripping vapors for the trays below the feed are furnished by the reboiler. As these hot vapors rise in the bottom trays they tend to strip the lighter constituents from the liquid flowing down the column. The vapor rising from each successive tray becomes lighter and lighter while the liquid flowing toward the reboiler becomes heavier and heavier, until the liquid leaving the reboiler is free of the undesired light constituents. For the purpose of this paper, this is a workable description of a fractionating column.

Heat Input-Reflux Rate

The heat input to the fractionating column reboiler is balanced approximately by the reflux rate. The more steam input to a reboiler, the greater the reflux rate required. With a fixed number of trays, the purity of the products will be a function of the rate of reflux or so-called turnover within the column. Therefore, all fractionating columns are controlled for purity of product by setting the heat input to the reboiler at a fixed amount and controlling the temperature in the top section of the column by a variable reflux rate, or by setting the reflux at a constant rate and controlling the bottom temperature by a variable steam rate.

The success of operation of a fractionating plant depends on providing a constant feed rate. The feed rate is set either with a flow control instrument or by a level control instrument on the raw gasoline surge tank. If a level control is employed, it should be set on a wide throttling range to minimize variations in feed rate. By starting the fractionation plant with the feed control in service, the charge pump can be started and attention concentrated on the first column.

The deethanizer will operate without the use of a temperature controller. As it is necessary to lose some propane out of the top of this column in order to obtain liquid reflux, the top temperature is not controlled but carried as low as the cooling water temperature will allow. The operator can circulate the full amount of cooling water through the reflux condenser while the column is being charged, the colder this temperature the less the loss of propane. At the same time steam can be admitted to the reboiler. This use of a hot reboiler immediately flashes all the lighter constituents from the bottom and assures elimination of ethane and lighter from the bottom product.

It is now common practice to control the deethanizer reflux pump by the

level control instrument on the reflux accumulator. As the column is coming up to pressure, liquid will accumulate in the reflux accumulator. Since this pump is on automatic control, as soon as a liquid level is obtained the pump can be put in service. It must be realized that the column will build up pressure slowly since the percentage of ethane and methane in the feed is low. For a while the reflux pump will handle considerable quantities as heavy as butane which will flash overhead until the pressure is near design. When the pressure reaches the control setting, the pressure instrument controlling the non-condensed vapors from the reflux accumulator can be put in service. This control system greatly simplifies the startup and operation.

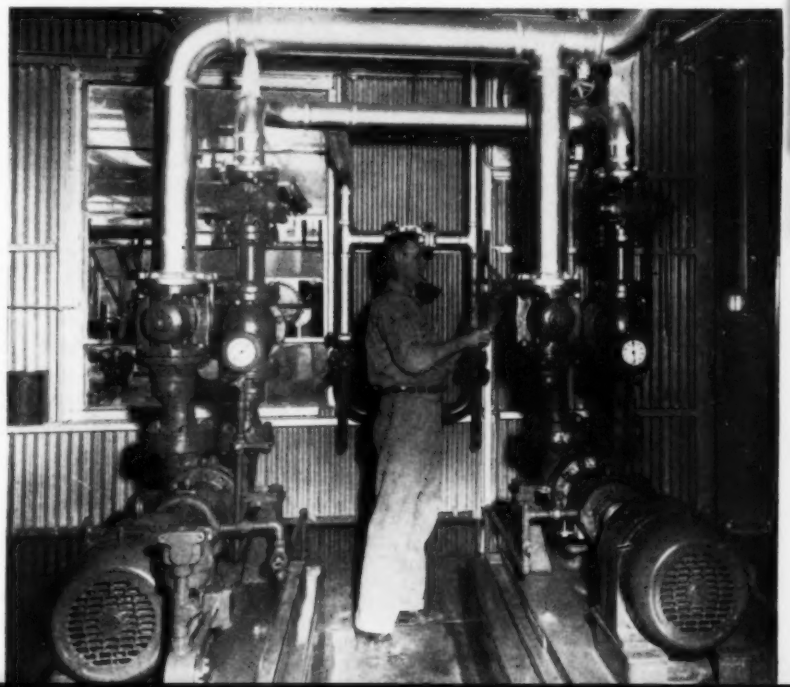
When a level is obtained in the deethanizer reboiler, the liquid level control is put in service and the product charged to the depropanizer. If later tests show that too great a quantity of ethane remains in the liquid leaving this reboiler, the operator merely increases the steam rate to the reboiler. This increases the turnover within the column and improves the purity of the separation. It is well to caution here that the temperature in this reboiler will vary with a constant steam rate due to variations in composition of the feed. This temperature is not to be regarded as a control temperature.

The depropanizer separating a specification propane product overhead will be controlled by the temperature and pressure in the top section of the column with a fixed rate of steam to the reboiler. As the temperature rises in the top section of the column above the control setting, additional reflux will be pumped back and vice versa. The steam to the reboiler will have to be set at a rate sufficient to substantially completely strip the propane from the bottoms. This reboiler then will act identically to the deethanizer reboiler and some variation in bottom temperature is to be expected.

While innumerable methods of controlling the top temperature and pressure of a depropanizer are employed, the procedure for lining out the column will be the same. The operator can close the valve drawing propane off to storage and manually control the reflux over this column as the liquid is condensed and the pressure increases. Gradually as the level builds up, the reflux rate can be increased. However, no liquid need be drawn off to storage until the column is up to pressure and the temperature is approximately at design. When the reflux has reached the point where sufficient liquid is available to approach the control setting, the temperature control can be put in service. While the operator is obtaining sufficient reflux for operation, the steam rate to the reboiler can be set at the design rate as the column is being charged. The steam will continuously maintain the reboiler at a temperature high enough to eliminate the propane from the bottoms. When the level is obtained in this reboiler, the level control instrument can be set to charge this product to the debutanizer.

The debutanizer making a specification bottom product will be controlled by temperature and pressure controllers on the reboiler. By setting the temperature and pressure of the bottom product, the vapor pressure of the product is fixed. The bottom temperature can be varied by the steam rate to the reboiler with a fixed reflux rate to make any desired vapor pressure gasoline for which the column has been designed. Increasing the bottom temperature at the same column pressure decreases the vapor pressure. Since the steam rate to the reboiler will vary for constant temperature, the reflux to this column is fixed at a rate high enough to obtain the desired purity of butanes in the overhead. The column startup can proceed in the same manner as the depropanizer, by manually controlling the reflux rate until sufficient liquid is available to put the flow controller in serivce. In this manner it is not unusual to make specification propane and butane with the first products withdrawn to storage. While the original gasoline going to storage may be low in vapor pressure, this can be adjusted when the column has been lined out and check tests performed.

This brief process explanation of the startup of an entire process section of a natural gasoline plant omits mention of mechanical adjustments because it is realized that operators are very capable of performing them. The paper attempted to give only a general process knowledge with principles that could be applied to any plant.



Typical reflux pump installation. The propane, butanes and gasoline are the valuable constitutents to be recovered, while the methane and etane ethane are the undesirable components.

Large Fluid Unit Turnaround Is Made in Thirteen Days

A COMPLETE turn-around, involving overhaul and inspection, was made in 13 days by the maintenance and operating crews of Sinclair Oil Corporation of the fluid catalytic cracking unit at the Marcus Hook, Pa., refinery. The unit is the largest on the East Coast and has been in continuous high capacity operation for approximately a year. It has a capacity of 28,000 barrels per day and 22,000 pounds per hour coke burning capacity.

During the run, 8,360,145 barrels of heavy gas oil boiling between 650 endpoint heating oil and 200 penetration asphalt were processed at an average stream-day feed rate of 23,200 barrels. Maximum conversion with resultant maximum coke burned was maintained throughout the run. Stream efficiency for the run, including the turn-around and miscellaneous losses, was 96.2 percent.

The high efficiency obtained is attributed to three main factors: the outstanding engineering work in design of the unit with maintenance problems a prime consideration; planning organization work done before the unit came down and the follow-up during the turnaround, and the enthusiastic cooperation and the high output of all crafts and workmen on the unit both during the run and during the shutdown.

It would not be correct to consider any one of these three items foremost, because successful handling of a maintenance problem of this magnitude requires equal attention for each item. However, since the planning and actual work was done exclusively with local refinery personnel, there was no divided responsibility and a maximum of cooperation between crafts.

Some of the outstanding engineering features that aided in the turn-around of the unit are listed below:

1) Careful layout of vessels and piping, permitting free access to all items requiring service and inspection.

2) Permanent installation of hoist trolleys, cranes or davits for all items requiring regular turn-around service.

3) Ground level layout and space to accommodate truck delivery of heavy parts to the crane or hoist serving these particular items.

4) Installation of oversize manways; regenerator, 74 inches, and reactor, 60 inches.

5) A large size 200 feet per minute, two-ton capacity freight elevator to the regenerator grid level.

6) A central service well and hoist serving all elevations of the unit.

7) Location of manways at main floor levels.

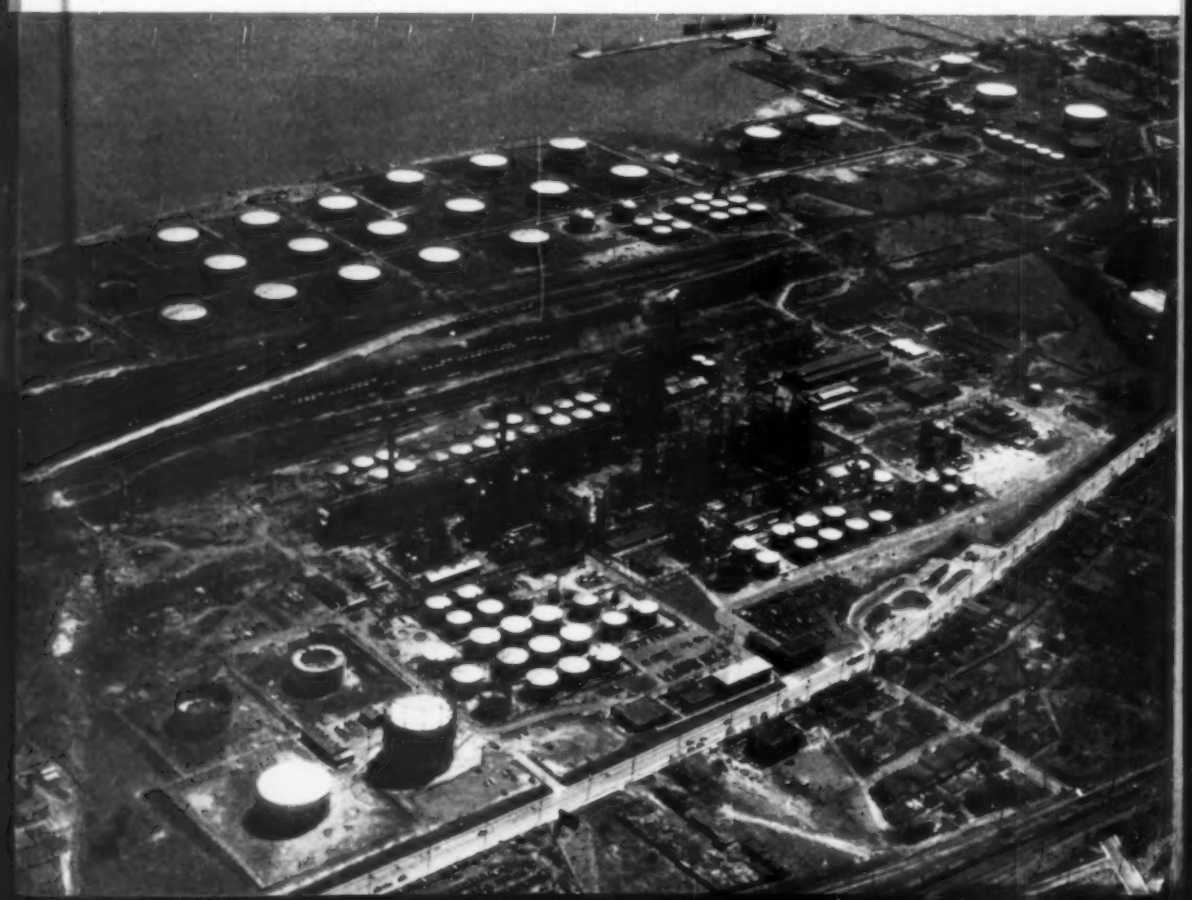
8) Centralized grouping of control instruments.

9) Streamlining and sizing of lines and valves to minimize erosion.

10) Generous supply of catalyst cleanup, utility air, steam, and water connections throughout the unit.

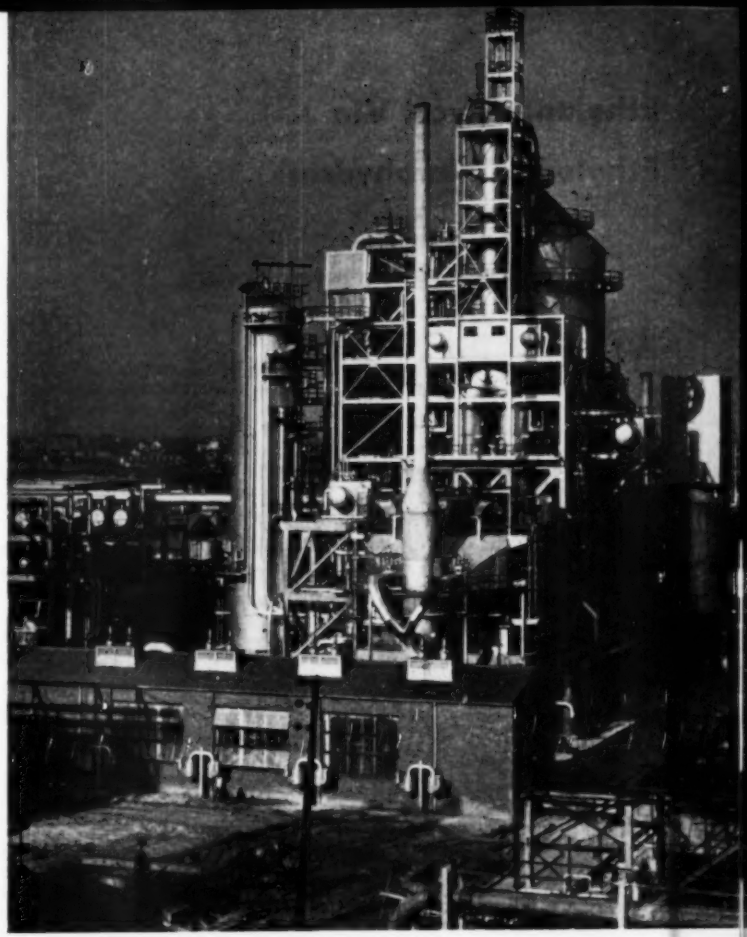
Organized planning of the turn-around started when the unit went into operation. Ten months later, plans for the shutdown had progressed to the point

Airview of Sinclair Oil Corporation's refinery located at Marcus Hook, Pa.



THIS IS the story of a turn-around of a 28,000 barrel per day fluid catalytic cracking unit —the largest unit operating on the East Coast. It was written by personnel at Sinclair's Marcus Hook refinery.

While the story is limited to a brief description of the planning and engineering technique involved, and the time required and the results obtained—the editors believe that the reader will sense the pride of achievement in a job well-done, and the enthusiasm and high morale of every man in the crews that worked on the turn-around—from top management to the elevator operator on the unit.



The fluid cat cracker at the Marcus Hook plant of Sinclair Refining Corporation

where working lists had been made up and given to all operating and maintenance foremen. These lists broke down all jobs in detail and included preliminary estimates of manpower requirements for each craft. As the time of the shutdown approached, revisions and additions were made to these lists and final plans were developed.

The keynote of all the preliminary planning was "not to do any work during the shutdown period which could be done while the unit was in operation." Adoption of this policy saved manpower during the shutdown and concentrated supervision on the jobs necessary during the shutdown.

Organization of the turn-around consisted of the following outstanding features: 1) Designation of the plant assistant master mechanic exclusively to the turn-around as job foreman for a period of approximately two months prior to the shutdown and throughout the turn-around. The job foreman had authority to direct all foremen and subforemen assigned to the unit. 2) The unit was completely equipped with a communication system consisting of additional telephones on the regular operating communication system, and in addition a public address system was installed with speakers located around the unit. One man was assigned exclusively to the operation of the communications system. 3) A material dispatcher was located and equipped with telephone facilities at a point where the material was received from storage and disbursed to the unit. 4) Materials had been checked extensively before the unit came down and were stored in designated areas adjacent to the unit immediately before the shutdown. 5) Transportation equipment was assigned exclusively to the unit. 6) An elevator operator was assigned to the unit.

It was unusually interesting to note that everyone who worked on the unit during the shutdown feels that the jovial disposition of the man assigned to operation of the elevator did more to raise and maintain the morale of the workmen on the unit than did any other single factor.

When the unit had been stripped, it was found to be in generally excellent condition. The regenerator brickwork showed no wear, and only three points of heavy erosion were found in the ducts: 1) The injection nozzle in the spent catalyst riser was renewed, as was the lower spent catalyst slide valve. 2) The reactor cyclone spindles were renewed. 3) Some patching was required in the stripping well where steam impingement had caused erosion.

No major repairs were necessary; however, several changes were made for increased safety or to facilitate maintenance: 1) The valves on the gas compressor suction were moved to a point outside of the building as a safety measure. 2) Valves were installed at the main fractionator condenser banks to permit maintenance without interruption of operation. 3) A by-pass was installed on the fixed feed preheater to allow the tubes in the heater to be cleaned during the run on future operations.

The balance of the turn-around work was routine in nature, including such work as compressor and pump overhauling, tube bundle cleaning, heater cleaning and repairing, and a thorough inspection of lines and equipment. It should be pointed that since this was the first shutdown of this fluid unit, a more extensive opening of vessels and inspecting was made than might be considered normal on a turn-around; however, a part of this additional work was done for engineering and future planning purposes.

The turn-around used a total of 3760 manhours prior to the shutdown and 25,890 manhours during the shutdown. Broken down into crafts, the manhours were distributed as follows:

Craft	Hours
Boilermakers	2,597
Bricklayers	535
Carpenters	1,487
Crane Operator	216
Electricians	1,109
Insulators	751
Instrument Men	1,441
Labor	3,590
Machinists	2,320
Painters	848
Pipefitters	8,192
Riggers	1,923
Still Cleaners	409
Transportation	326
Welders	3,916
Total	29,650

From the experience gained from this turn-around, officials expect that those in the future can be accomplished without increased downtime, even though increased repairs can be anticipated as the equipment ages.

Ethylene Glycol Via Ethylene Chlorohydrin

PETER W. SHERWOOD

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MOST OF the ethylene oxide consumed in the United States is produced by the indirect synthesis from ethylene via ethylene chlorohydrin. This article reports technical details involved in both steps of the process and discusses some of their limitations. Major pieces of equipment are described and the final purification of ethylene oxide and its conversion to glycol is explained.

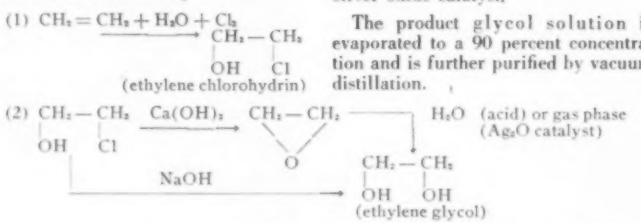
AN EARLIER article[1] on manufacture of ethylene glycol by air oxidation of ethylene pointed out at the time that this process is responsible for only a comparatively small portion of the total American glycol output. From an economic point of view, it was concluded that oxidation plants constructed in 1948 would be hard pressed to make a successful competitive stand against ethylene glycol plants working by the more traditional chlorohydrination process.

These findings were confirmed by the fact that most of last years' ethylene glycol expansion took place in chlorohydrination plants. Employing this process, American production of ethylene glycol was expanded during 1948 by roughly 105 million pounds to reach a grand total of 315 million pounds. The field was newly invaded by Wyandotte Chemical Corporation at Wyandotte, Mich., which took up the manufacture of ethylene and propylene gylcol mixtures. Pure ethylene glycol was newly produced by Jefferson Chemical Corporation at its Port Arthur, Texas, plant. Both of these companies decided to employ the chlorohydrination process. At the same time The Dow Chemical Company and Carbide and Carbon Chemicals Corporation have greatly expanded their facilities.

Many firms have thus turned their attention to a process which has been practiced in the United States in one form or another, since 1922. This process for the manufacture of ethylene glycol via ethylene chlorohydrin is particularly remarkable for the secretiveness which has surrounded its operation. With the exception of patent information, the American technical literature has been shrouded in nearly complete silence on this very basic and significant process.

Outline of the Process

The manufacture of ethylene glycol via ethylene chlorohydrin takes place in two fundamental steps:



This process for the manufacture of ethylene glycol was practiced in the laboratory of Carius as early as 1863.[2] The first systematic study of the process was published by Gomberg in 1919.[3] Industrial progress came with the important developments of Curme[4] and others which finally succeeded in making a laboratory-curiosity selling for $1 per pound in 1922 into a tonnage chemical available at 12-14 cents per pound today.

A typical flow sheet for the industrial production of ethylene oxide and ethylene glycol from chlorohydrin is shown in Figure 1.

Ethylene is converted to ethylene chlorohydrin by the action of hypochlorous acid at slightly elevated temperatures. The hypochlorous acid, present in aqueous solution, is generated for this purpose by the reaction between chlorine and water or by the action of chlorine on aqueous sodium hypochlorite. Some of the unconverted ethylene is recycled to the reactor. The remainder is vented. Ethylene dichloride is the major by-product of this reaction.

Without further concentration, the ethylene chlorohydrin solution is treated with alkali at temperatures near the boiling point of water. The alkali is supplied in the form of sodium hydroxide or a sodium hydroxide-sodium carbonate mixture if it is desired to produce glycol directly. More commonly, the reaction is carried out at a pH of approximately 8 by employing milk of lime. The product formed under these conditions is predominantly ethylene oxide which is concentrated by vaporization from the reaction phase. Ethylene oxide is further purified by a series of fractionations. A product of 98-99+ percent purity can eventually be obtained in this manner.

Ethylene oxide has a large market as such. It can moreover be readily converted to ethylene glycol by the action of a dilute aqueous solution of a strong acid or by reaction with water at elevated temperatures and pressures. A third alternative is the vapor phase hydrolysis of ethylene oxide over a silver oxide catalyst.

The product glycol solution is evaporated to a 90 percent concentration and is further purified by vacuum distillation.

Manufacture of Ethylene Chlorohydrin

In his important study on optimum conditions for the batchwise production of ethylene chlorohydrin from ethylene and chlorine in an aqueous medium, Gomberg[3] concluded that good stirring is of primary importance in order to promote the rate of ethylene absorption. He also concluded that the yield of chlorohydrin did not vary as a function of temperature in the range 0-20° C. The presence of some ethylene chlorohydrin in the water phase was found to promote the rate of ethylene absorption very appreciably, and Gomberg recommended that some of this material be recycled to the reaction stage. Up to a concentration of 5 percent ethylene chlorohydrin excellent yields were obtained. As the product concentration increased above this point, however, there was a tendency for ethylene dichloride formation. This side reaction did not become very serious until the ethylene chlorohydrin concentration had reached eight percent. After this point the main reaction was rapidly suppressed and the reaction progress became unsound.

Murray[5] reported recently the results of an investigation of this reaction, operated in continuous fashion.

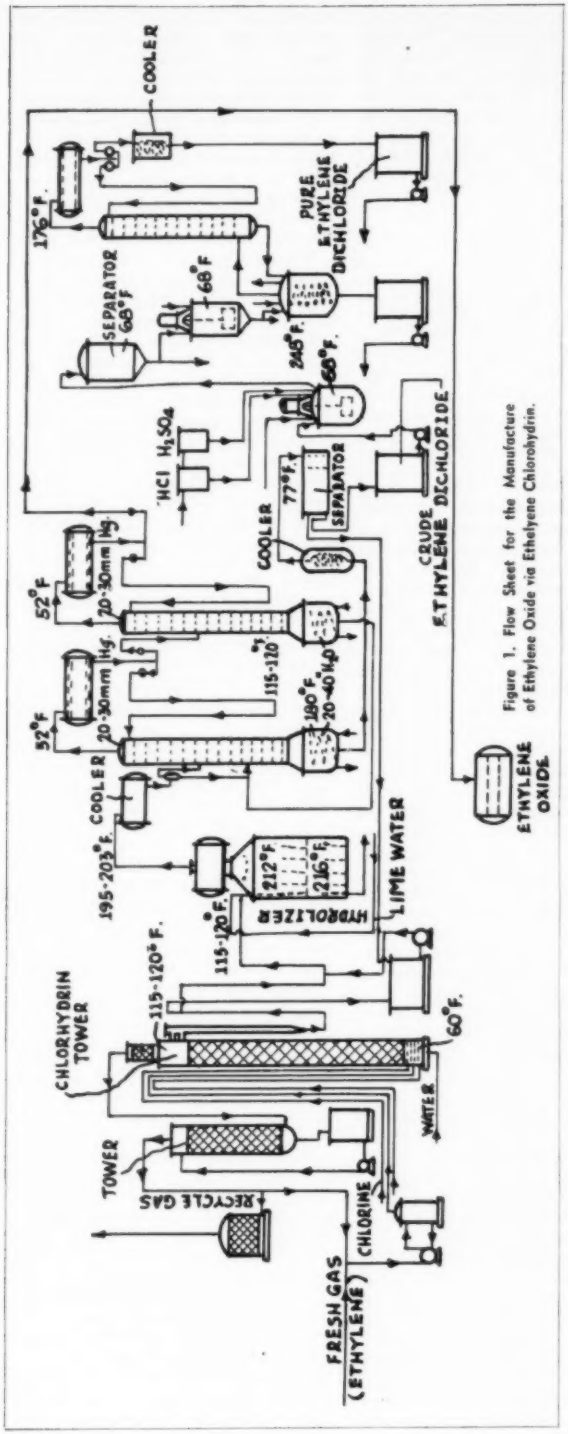


Figure 1. Flow Sheet for the Manufacture of Ethylene Oxide via Ethylene Chlorohydrin.

Murray extended Gomberg's data to 50° C. and finds that, up to this point, temperature has no significant effect on the ethylene chlorohydrin yield. Murray carried out his reaction in a glass column containing a moving stream of aqueous ethylene chlorohydrin solution into which he introduced ethylene and chlorine, taking care that the ethylene was always in slight excess. Part of the ethylene chlorohydrin solution was withdrawn as product, the remainder was diluted with water and recycled to the reactor. In this manner, the average product concentration in the reaction space was always greater than would be obtained in a batch process. Accordingly, Murray found that he was unable to get satisfactory yields if he permitted the concentration of his solution to reach the eight percent maximum recommended by Gomberg. For continuous operation of this process, the maximum useful concentration of ethylene chlorohydrin in the reaction medium was 5.1 percent.

Murray identified not only ethylene dichloride but also appreciable amounts of 2:2′ dichlorodiethyl ether in his product. He was able to concentrate ethylene chlorohydrin to a nearly anhydrous product by entrainment of the water-ethylene chlorohydrin azeotrope with ethylene dichloride. The resulting organic mixture could be readily fractionated.

The over-all reaction for the production of ethylene chlorohydrin shows the production of hydrogen chloride as a byproduct.

$$CH_2=CH_2 + H_2O + Cl_2 \longrightarrow \underset{\displaystyle OH}{\overset{\displaystyle |}{CH_2}}-\underset{\displaystyle Cl}{\overset{\displaystyle |}{CH_2}} + HCl$$

Attempts by Gomberg and others to promote the reaction by the neutralization of byproduct hydrogen chloride have met with failure. One reason for this is that the equilibrium is not very greatly affected by the removal of only one component of the primary reaction product of the two-step mechanism which is generally assumed:

(a) $H_2O + Cl_2 \longrightarrow H^+ + Cl^- + HOCl$

(b) $HOCl + CH_2=CH_2 \longrightarrow \underset{\displaystyle OH}{\overset{\displaystyle |}{CH_2}}-\underset{\displaystyle Cl}{\overset{\displaystyle |}{CH_2}}$

As the reaction progresses, the chloride ion concentration is built up and reaction (a) is displaced toward the left, favoring the formation of ethylene dichloride. Frahm[6] found that by removing both the hydrogen and the chloride ion from the reaction zone (e.g. by the addition of lead acetate), he was able to suppress the formation of ethylene dichloride very appreciably. The patent literature reports attempts to remove ethylene chlorohydrin from the reaction zone as soon as formed with a view to suppressing its conversion to ethylene dichloride. One example is a series of three patents by Brooks[7] which proposes that the chlorohydrination reaction be carried out in the presence of organic solvents such as carbon tetrachloride with this end in view. A look at the partition coefficient of ethylene chlorohydrin between water and carbon tetrachloride casts serious doubt on the efficacy of this method.

Catalytical Reaction Attempts

Attempts have been reported to carry out the chlorohydrination reaction catalytically. Frahm[6] states that the presence of small amounts of cupric chloride, nickel chloride, or iron salts brings about a great increase in reaction rate and an appreciable boost in yield. Operation in the presence of these

catalysts permitted the use of a slight chlorine excess without undue increase in the yield of byproduct ethylene dichloride. From this and other somewhat shaky evidence, Frahm concludes that the reaction mechanism is not as proposed above. Frahm suggests that the reaction proceeds in the following manner:

$$CH_2=CH_2 + O \longrightarrow CH_2-CH_2 \xrightarrow{HCl} CH_2OH-CH_2Cl$$
$$\qquad\qquad\quad \diagdown\ \diagup \qquad\qquad\qquad\quad$$
$$\qquad\qquad\quad\ O \qquad\qquad\qquad\quad$$

Frahm's statements are directly contradicted by Moureu and Dode[7] who support the first reaction mechanism outlined above on the evidence of relative reaction rates and the continual presence of HCl. On the other hand, Bozza and Mamoli[9] find that the reaction rate is completely independent of the HOCl concentration and that it is strictly proportional to the rate of ethylene absorption.

E. A. Shilov et al.[10] deny that the presence of cupric chloride has any effect on the addition reaction.

The necessity for preventing direct contact between gaseous chlorine and ethylene (which would result in the formation of ethylene dichloride) has led to the development of a number of processes in which hypochlorous acid is generated independently in the absence of ethylene. The chlorine-free solution is then treated with ethylene in a second reactor to yield ethylene chlorohydrin. A most signficant patent of this type is due to Curme and Young[4] and has attained industrial significance. This process calls for the chlorine-treatment of sodium hypochlorite solution. In this manner hypochlorous acid and sodium chloride are formed:

$$NaOCl + Cl_2 + H_2O \rightarrow 2HOCl + NaCl$$

The product of this reaction is passed to a second tower in which it is contacted with excess ethylene for the formation of ethylene chlorohydrin. The effluent from this tower contains some sodium hypochlorite and sodium chloride along with unreacted hypochlorous acid and the main reaction product, ethylene chlorohydrin. Further chlorine treatment of this solution is possible to convert the residual sodium hypochlorite to hypochlorous acid which can then, in turn, be reacted with additional ethylene. Process details on industrial performance of this process have never been made publicly available. The success of the process depends decidedly on details of mechanical arrangement and chemical conditions. Some details on this mode of carrying out the chlorohydrination reaction have been furnished by E. C. Williams[11] for the chlorohydrination of allyl chloride. Williams finds that the presence of chloride ion has a definitely harmful effect on the yield of the chlorohydrin. A yield of only 91.4 percent could be obtained when the chlorohydrination was carried out by means of hypochlorous acid derived from the chlorination of aqueous sodium hypochlorite. The reaction of allyl chloride with a solution of distilled hypochlorous acid resulted in a yield of 95.2 percent glycerol dichlorohydrin. The use of distilled hypochlorous acid is, however, industrially not feasible and the loss in yield must be taken in submission to economic demands.

German Process

Considerable information on process details has become available as a result of the investigations of German chemical plants.[12,13,14] In these plants, ethylene chlorohydrin is universally manufactured by the direct reaction of chlorine, water, and ethylene. The reaction is carried out in steel towers which are internally lined with a layer of rubber and a thickness of acid brick. The towers consist of four sections, of which the upper three are packed with Raschig rings while the bottom section is kept free of obstructions. Chlorine is fed into the bottom of the tower while ethylene is introduced at a higher level. It is essential that these two feed lines be placed at a sufficient distance to permit the reaction $H_2O + Cl_2 \longrightarrow HCl + HOCl$ to be completed before any ethylene is introduced into the reaction medium. The above discussion has demonstrated the need for this arrangement if the formation of ethylene dichloride is to be minimized. In some American plants this conclusion is taken to the extreme of providing a separate mixing tower for chlorine and water followed by an ethylene reaction tower.

Water is continuously introduced into the bottom of the chlorohydrination reactor. Lean gas is continuously withdrawn from the top of the tower after passage through a water spray and is cleaned in a caustic scrubbing tower after which a portion of it is recycled. The product of the reaction is removed at the top of the tower as a 4.5 to 5 percent solution of ethylene chlorohydrin in water.

The reaction is carried out at 120° F., a temperature which is spontaneously developed from cold feed by the exothermic heat of reaction. An excess of ethylene must be carefully maintained at all times, and the top gas contains some 15 to 20 percent ethylene. Not all of this is lost since a sizable portion of the top gas is recycled. An excess of chlorine must be scrupulously avoided, partly because it tends to decrease the yield and partly because it creates a serious corrosion problem in the gas lines. There is also evidence that an explosion has been caused due to the diffusion of excess chlorine into the ethylene feed line.

The purity of the feed ethylene is not particularly critical from a chemical point of view. Mixed with recycle gas, ethylene generally enters the chlorohydrination tower at a 70-75 percent concentration. However, concentrations as low as 40 percent have been used successfully. Where such low concentrations are employed, larger gas blowers are necessary and longer contact time is required in the tower. Economic considerations therefore favor generally the use of a reasonably pure raw gas. The presence of higher olefins is objectionable because they will form the corresponding chlorohydrin, thus raising chlorine usage and introducing a considerable purification problem. Similarly, the acetylene concentration should be below .5 percent in the feed gas. Hydrogen introduces an explosion hazard and should be present in only small percentages.

Chlorine consumption is approximately seventeen pounds per hundred cubic feet of 96 percent ethylene. Water rate is 45 gallons per hundred cubic feet ethylene. Ethylene chlorohydrin yield may be as high as 85 to 89 percent of the ethylene utilized. Ethylene dichloride accounts for some 5-8 percent of the useful ethylene. Because of some ethylene losses in the vent gas, the overall ethylene chlorohydrin yield does not normally exceed 75-80 percent of theory.

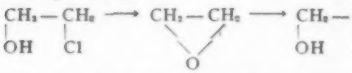
Conversion of Ethylene Chlorohydrin to Glycol

In the presence of alkali, ethylene chlorohydrin can be readily hydrolized to ethylene glycol or ethylene oxide at elevated temperatures. The reaction velocity between chlorohydrin and aqueous sodium hydroxide has been studied by Smith[15] and by Porret[16]. From their works the following generalized conclusions can be drawn regarding this reaction:

1) The reaction is of the second order, indicating that the controlling step in the reaction mechanism is bimolecular.
2) Neutral salts affect the reaction velocity only slightly.
3) The reaction velocity is greatest in dilute solution. This effect is not very great, however.

In industrial practice, the hydrolysis is generally carried out on the dilute solution received from the ethylene chlorohydrin plant. Treatment with sodium hydroxide results in the formation of appreciable quantities of dichloro-ethyl ether. By proper adjustment of the pH, this byproduct and the resultant loss in yield can be minimized. A more suitable reagent from this point of view is sodium carbonate. Here, however, one encounters the drawback of carbon dioxide evolution which may result in pressure build-up and other difficulties. This problem is solved by Williams[11] in the hydrolysis of glycerol dichlorohydrin by employing a sodium hydroxide-sodium carbonate mixture. Enough sodium hydroxide is present to absorb the carbon dioxide evolved from sodium carbonate added gradually to the reaction phase.

Industrially, certain advantages are achieved by converting ethylene chlorohydrin to glycol by the indirect route via ethylene oxide.



For one thing, a better yield of glycol can be obtained by the two-step process. Furthermore, it makes possible the substitution of cheap lime for caustic soda in the hydrolysis reaction. Industrially, milk of lime has therefore become the hydrolizing agent par excellence in the manufacture of ethylene glycol.

The lime is generally employed as an aqueous slurry containing 10 percent CaO. To prevent corrosion problems at a later stage in the process, the lime should be carefully freed of ammonia. Certain other impurities in lime, notably magnesia, tend to promote the formation of acetaldehyde, thereby reducing the ethylene oxide yield. A slight excess of lime above theoretical requirements is maintained in order to insure complete recovery of ethylene oxide and to prevent the occurrence of a corrosive condition.

The reaction between milk of lime and the dilute chlorohydrin solution from the chlorohydrination reactors is generally carried out continuously. The equipment consists of vertical or horizontal cylinders provided with internal baffles to prevent the mixing of feed and product streams and to assist in maintaining uniformity at any cross-section of the reaction stream. Agitation is provided by the introduction of live steam into the system. A typical horizontal hydrolizer is shown in Figure 2.

The mixed feed enters at one side of the reactor where it is soon heated to 205° F. by live steam. In the early stages of the reaction, the temperature is maintained at this point in order to prevent excessively fast development and evolution of ethylene oxide which may result in operating difficulties due to frothing and splashing. Eventually, the temperature is allowed to rise to 215° F. to complete the hydrolysis. Normal hold-up time in the hydrolizer is fifteen to thirty minutes. The reaction is carried out at slightly positive pressure.

The reactor is surmounted by a dephlegmator, operating at 185° F. exit temperature, which returns any volatilized ethylene chlorohydrin and most of the evolved steam to the reactor. Ethylene oxide, ethylene dichloride and some steam pass through this partial condenser. This gas stream is the desired product. A typical analysis of the product stream is 40 percent ethylene oxide, 4-5 percent ethylene dichloride, some acetaldehyde and ethylene chlorohydrin. The remainder is water. This composition is, of course, subject to wide variations, depending on the dephlegmating efficiency of the cooler and the exact operating conditions inside the reactor.

The spent lime slurry leaving the reactor is waste product and is discarded. It still contains some ethylene oxide which has failed to volatilize and accounts for most of the yield losses in the hydrolysis reaction.

Some typical performance data have been reported for the hydrolysis unit of the Zweckel plant of I. G. Farbenindustrie.[13] These, shown in Table 1, represent upper and lower operating conditions encountered at this plant:

TABLE 1

Water gph.	Chlorohydrin lbs./hr. (dry basis)	Lime lbs./hr. (dry basis)	Ethylene Oxide lbs./hr.	Steam M lbs./hr.
4250	1600	1500	725	10.4
6400	2400	2300	1250	16.3

The ethylene oxide yield for these two operating days is seen to be 82.5 percent and 94.5 percent of theory, respectively. The lower of these yields is not in keeping with common experience and is probably due to faulty operation. Yields of 90-95 percent are quite generally obtained in this reaction.

Purification of Ethylene Oxide

Ethylene oxide and other gases leaving the dephlegmator atop the hydrolysis reactor are cooled to 80-85° F. in a tubular heat exchanger. The condensate is separated from the residual gas phase. Both phases are introduced into the primary distillation column at two different plates.

The primary distillation column, made of steel, is operated for the separation of ethylene oxide from water. To avoid hydrolysis and side reactions of ethylene oxide at this stage, the column is generally operated at a head pressure of 20-30mm Hg abs. Top temperature is maintained at 33-35° F. and the circulation of a refrigerant or refrigerated brine solution through the reflux condenser is therefore required. Operation with a reflux ratio of 1 or 2, which is common practice, calls for 45 to 50 plates in the column. Accordingly, a pressure of some 60 to 80mm Hg absolute, may be expected in the still pot with a corresponding temperature level.

Ethylene oxide, removed as overhead product, is subjected to a second distillation for purification purposes. Again, a 50-plate column is common practice. A top pressure of 30mm Hg absolute, and a temperature of 35° F. is maintained. The ethylene oxide produced in the course of this distillation analyses 98-99 percent ethylene oxide. This product still contains about .5 percent acetaldehyde, a compound which is objectionable for many uses because of its tendency to create a color in the product. The acetaldehyde content can be further reduced by a third distillation. For special purposes, requiring ethylene oxide purities well in excess of 99 percent, a fourth distillation may actually be necessary. The third and fourth distillations—and sometimes even the second—are often carried out in batch columns because of the small volumes involved.

Hydrolysis of Ethylene Oxide To Ethylene Glycol

Ethylene oxide, which may be looked upon as the anhydride of glycol, may be converted to its mother compound by the reaction with an equimolar quantity of water. The reaction can be carried out in aqueous phase by operating either in the presence of small quantities of strong acids which act as catalysts, or at evelated temperatures and correspondingly high pressures. The former of these approaches is most suitable for use when ethylene oxide is to be absorbed from a gaseous mixture and hydrolized simultaneously. This situation occurs particularly in the manufacture of ethylene glycol by air oxidation of ethylene. Reaction conditions and equipment have been discussed in an earlier article published in this journal.[1] The conversion of ethylene oxide by means of water under pressure is particularly suitable for the product of the chloro-

hydrination process which arrives in concentrated form. The pressure process makes possible the utilization of carbon steel equipment.

Ethylene oxide is mixed with about six times its weight of water. The solution is introduced into the reaction tower where it is maintained at 380° F. and about 200 psig. The process may be operated either continuously or batchwise. Residence time at reaction temperature is about one hour.

The reaction product is delivered to a multiple-effect evaporator in which it is concentrated to 90 percent glycol. Final dehydration is carried out by distillation under vacuum. Secondary stills separate ethylene glycol from diethylene and triethylene glycols. These latter separations can be carried out in a batch column or in two successive continuous vacuum columns.

The conversion of ethylene oxide to glycols in this reaction is essentially complete. The formation of higher glycols reduces the yield of ethylene gylcol to about 92-95 percent. The water-to-ethylene oxide ratio stated above represents about the optimum for efficient operation. A larger amount of water would result in greater dilution of the product without a corresponding increase in yield. Low water-to-oxide ratios promote the formation of higher glycols.

Another possibility for the conversion of ethylene oxide to glycol consists in the vapor phase hydration over a silver oxide-on-alumina catalyst.[17] Operation is carried out at 300-480° F., and a yield of approximately 80 percent is realized. Conversion per pass is 20-30 percent.

Over-all View of the Process

Over-all process yield in the production of ethylene oxide via ethylene chlorohydrin is about 70 percent. As a byproduct some 5-9 percent ethylene dichloride can be recovered. A typical materials and energy balance obtained at Ludwigshafen has been reported[13] and is shown in Table 2.

TABLE 2

A. Materials and Power Consumed Per Ton Ethylene Oxide.	
Ethylene	.91 Tons
Chlorine	2.14 Tons
Milk of Lime (100% CaO)	2.03 Tons
Sodium Hydroxide	.026 Tons
Steam	10.9 Tons
Electricity	143 kwh
Water	73,000 gallons
Nitrogen	350 cu. ft.
Compressed Air	100 cu. ft.
B. Byproducts Per Ton Ethylene Oxide	
Pure ethylene dichloride	.16 tons
Chloro-ether tar residue	.09 tons

First cost of chlorohydrination plants compares very favorably with direct oxidation plants. In years of high construction costs, such as the present era, the chlorohydrination process may be looked upon as being competitively superior for the manufacture of ethylene oxide and glycol from ethylene. This picture may be seriously changed by a sizable increase in the cost of chlorine or by sufficient improvement in the oxidation process to reduce the heat abstraction problem within tolerable limits. The margin of profit in ethylene glycol manufacture for sale at 12-14 cents per pound is slim at best but the sales volume is tremendous today and its growth curve is still steep as important new uses are being developed for these two chemicals of first-rate importance.

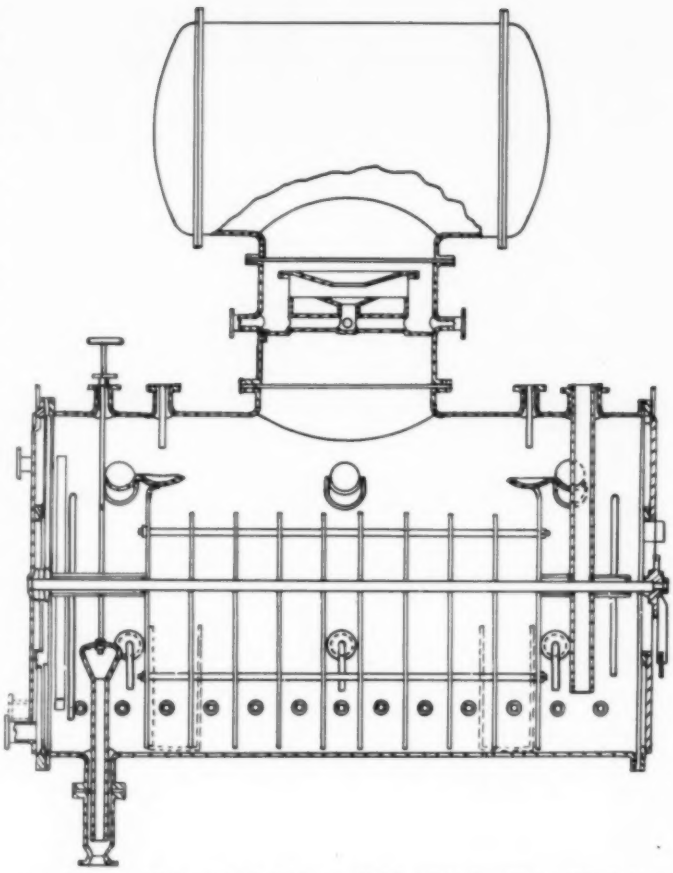


Figure 2. Horizontal Hydrolizer for the Production of Ethylene Oxide from Ethylene Chlorohydrin.

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Lubricating Oil Additives

Part II. Viscosity Index Improvers

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Tube Stills at the Paulsboro, N. J., Refinery, Socony-Vacuum Oil Company, Inc. Used for Crude Oil Cracking. Still at right is a combination atmospheric-vacuum still while other is atmospheric only.

THE degree of change of viscosity with temperature, i.e., the viscosity-temperature susceptibility characteristics, are quite important if the oil is intended to lubricate machinery in intermittent service. If the change is small the lubricant begins to circulate freely as soon as the engine is started thus reducing wear of the moving parts. Otherwise proper circulation is not established until the engine is thoroughly warmed up. It has been found experimentally that in running an automobile, for instance, practically all the wear takes place during the warm-up period and not while the engine is driven for many long hours on the road.

For oils used in continuous service, such as turbine oils, the change in viscosity of the oil with temperature is of little if any practical importance. The ratio of the time during which an engine is warmed up to that when it is in operation is small, and the wear caused by starting up an engine may be neglected. The oil viscosity at the operating temperature therefore becomes of primary consideration. For these reasons the viscosity-temperature susceptibility characteristics are hardly ever included into the specification requirements for such oils except as an indirect criterion of some of their other properties.

The change in viscosity with temperature is estimated with a reasonable degree of accuracy from the viscosity-temperature chart developed by the American Society for Testing Materials provided no complications arise from congelation of wax. However, the method provides no means for an easy visualization of the temperature-viscosity characteristics of an oil or for classification purposes. This can be done by using the viscosity index numbers developed by Dean and Davis which found a wide use in the industry.

In developing the system viscosities of two typical series of oils were determined at 100° F. and 210° F. One of the series was prepared from Pennsylvania crude oil which showed the least change in viscosity with temperature among the naturally occurring products. The second series was similarly derived from a Coastal crude oil which showed the greatest change in viscosity with temperature. By assigning the value of 100 to the first series of oils and the value of 0 to the second series a mathematical relationship was worked out to express the spread in viscosities of the two oils with temperature as a function of the 210° F. viscosity of the individual oils. On this basis the viscosity-temperature susceptibility of any oil can be established in relation to the two standard series of oils by expressing it as a simple number.

The selection of the two reference crude oils was well justified but since the time the scale was developed oils were found which deviated beyond both extreme limits. Therefore it is not unusual to find viscosity indices exceeding 100 or reported as negative numbers.

In using the viscosity index scale undue importance should not be ascribed to small variations in viscosity indices particularly if the oils have a low viscosity. This is due to the exaggerated nature of the scale. For instance an error of 0.2 second in determining the Saybolt Universal viscosity at 210° F. of a 40 second oil, which is within the experimental accuracy of many commercial laboratories, may change the viscosity index number by about eleven points even if the viscosities at 100° F. are properly determined. The greater sensitivity

***VISCOSITY INDEX** improvers form an important class of additives which made possible the development of a number of outstanding lubricants. The available information regarding their behavior indicates that their performance depends to a very considerable extent on the nature of the oil employed in blending and that further radical progress in the preparation of high viscosity index products will come in all probability from this direction.*

A comprehensive list of patents prepared for this article shows the types of compounds which might be employed to achieve the desired purpose. However, not all of them are in commercial use because of unfavorable effects on some other oil properties or similar considerations. Nevertheless it may be expected that new materials will appear on the market in the future in direct competition with those already available.

Drums Being Filled with Lubricating Oil at Socony-Vacuum's Paulsboro Plant.

of the viscosity index scale in the lower than in the higher viscosity region may be also visualized from the comparison of the viscosity indices of the so-called "ideal" oils or oils showing no change in viscosity with temperature. Table 5 shows that such oils range in viscosity index from 269 to 158 depending whether their Saybolt Universal viscosity at 210° F. is 40 or 160 seconds respectively. Therefore it is much easier to show a numerical improvement in the viscosity index of lighter than of heavier oils.

TABLE 5
Viscosity Indices of Oils Showing No Change in Viscosity with Temperature

Saybolt Universal Viscosity At Any Temperature	Viscosity Index
40	269
50	223
60	203
70	192
80	185
90	179
100	175
110	171
120	168
130	165
140	162
150	160
160	158

Viscosity index improves on refining because various treating agents like sulfuric acid or solvents remove more or less selectively the predominantly aromatic type of compounds having low viscosity indices. However it is also possible to improve the viscosity index by blending light and heavy viscosity oils. The viscosity index of such mixtures is almost always higher than that calculated by arithmetical averages. The improvement is greatest for the largest difference in viscosities of the two components[1]. In some instances the viscosity index of the blend may be even higher than that of either one of its constituents. These peculiarities are explained at least partially by the viscosity blending characteristics of oils. In general, viscosity of a blend at any fixed temperature is lower than the arithmetical average calculated from the viscosities of its components. The lowering is less for the high than for the low temperature viscosities as it may be noted by reference to the viscosity blending charts. These divergencies of viscosities of blends from the arithmetical averages are in the direction that produce higher viscosity indices than the arithmetical averages of the component oils.

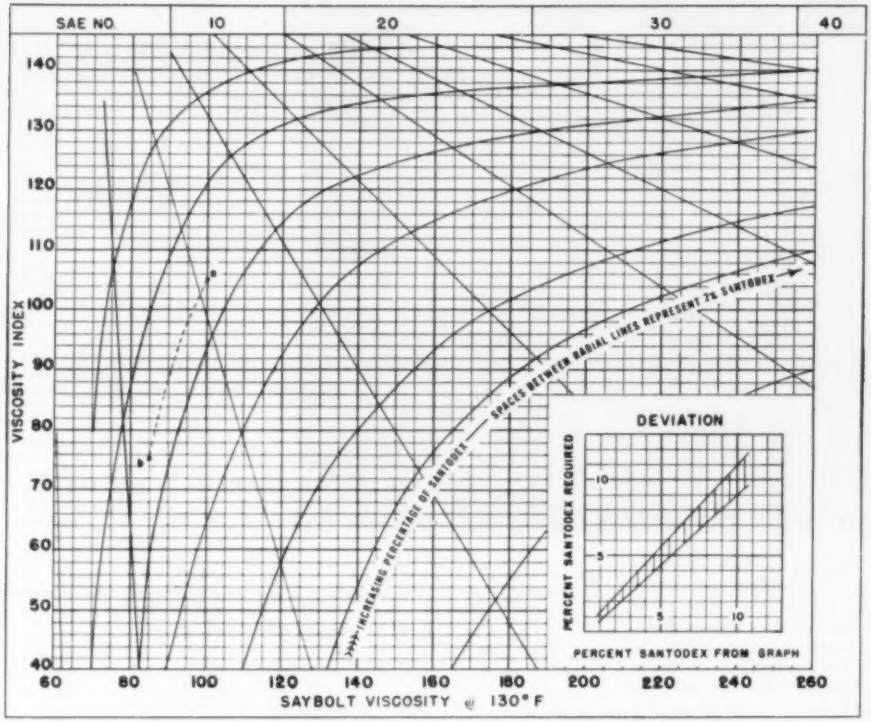
The maximum numerical degree of improvement in viscosity index is obtained with light viscosity oils and with oils having the lowest viscosity index. However, the viscosity index of blends is highest when the high viscosity mineral oils are employed although the numerical degree of improvement may be small. Likewise for oils of equal viscosities the higher is the viscosity index of the base oil, the smaller is the quantity of a viscosity index improver required to obtain the desired viscosity index.

Attempts of improving viscosity index of oils resulted in the development of a series of addition agents known as viscosity index improvers. As it may be deduced from previous discussions, they are high molecular weight compounds which have high viscosity index characteristics. The latter cannot be measured directly on the viscosity index scale because the scale does not extend beyond a relatively low viscosity index region. Viscosity index improvement of products containing such addition agents is thus secured by making the best use both of the inherent properties of these agents with respect to their low viscosity-temperature susceptibility characteristics and of the peculiarities of the viscosity blending phenomena.

Evans and Young[2] advanced an interesting theory to explain the action of viscosity index improvers and reasons why not all the high molecular weight substances are effective in this respect. They postulate that the improver exists in two phases in the oil. One phase is a molecularly dispersed improver in the oil and the second phase is a mechanically dispersed oil in the improver within the first phase. The efficiency of the viscosity index improver is at its maximum when it is completely dispersed in the oil. If the oil employed is a poor solvent for the improver, the efficiency of the improver is impaired. A good viscosity index improver should be less soluble in the oil at lower than at higher temperatures in order to exhibit the desirable properties. On the basis of this theory they investigated the possibility of enhancing properties of viscosity index improvers by adding to the mixtures substances of poor solubility characteristics. Some of these substances, such as dibutoxy ethyl phthalate, were helpful in this respect while others, like castor oil, were neutral. From these experiments they concluded that the desirable substances of this nature should be compatible with the oil to a greater extent than with the viscosity index improvers.

In obtaining a high viscosity index blend of a predetermined viscosity, the viscosity of the lighter component should be as low as possible. This permits incorporation of additional quantities of the viscosity index improvers and allows making maximum use of viscosity blending peculiarities of such mixtures. However, certain limitations do exist which prevent the use of extremely light oils in such blends.

Viscosity of the oil is closely related to its flash point and distillation range or volatility. If a very light oil is employed it may easily evaporate in the engine leaving behind the high viscosity index component, i.e., the viscosity index improver, which is too heavy to provide satisfactory lubrication. The ideal component of this type



This chart from Monsanto Chemical Technical Bulletin No. 0-48 (March 14, 1948)

TABLE 6

Viscosity Index Improvers

a. Natural Substances and Chemical Compounds

SUBSTANCE	U.S. Patent	Date	Inventory
Corn oil	2,144,773	1/24/39	Provine, R. W. and Bennett, H. T.
Ethers, thioethers or similar compounds of selenium or tellurium	2,236,896-7	4/ 1/41	Davis, L. L., Lincoln, B. H. and Burkitt, G. D.
Rubber	2,142,327	1/ 3/39	Musselman, J. M.
Wax-phenoxybenzoic acid	2,198,293	4/23/40	Reiff, O. M. and Otto, F. P.

b. Polymerization and Auto-Condensation Products

STARTING MATERIAL	U.S. Patent	Date	Inventors
Aromatic compounds containing triarylmethyl radicals	2,344,912	3/21/44	Young, D. W. and Evans, H. C.
Chlorinated ethylene	2,298,833	10/12/42	Muessig, C. W.
Esters of acrylic acids	2,407,954	9/ 7/46	Fenske, M. R. and Cummings, G. H.
Fatty oils	2,114,525	4/19/38	Eichwald, E.
	2,260,417	10/28/41	Whiteley, J. M. Jr.
Hydrocarbons	2,094,593	10/ 5/37	Gardiner, E. W., Green, J. W. and Lyman, A. L.
	2,239,501	4/27/41	Frolich, P. K. and Miller, F. L.
12-Hydroxystearic acid	2,147,647	2/21/39	Gleason, A. H.
Isobutylene	2,106,232	1/25/38	Zorn, H. and Rosinsky, W.
	2,227,692	1/ 7/41	Barnard, E. R.
	2,271,636	2/ 3/42	Frolich, P. K.
	2,304,874	12/15/42	Barnard, E. R.
	2,317,878	4/27/43	Bannon, L. A.
	2,334,996	11/23/43	Davis, G. H. B.
Organic silicones	2,407,037	9/ 3/46	Sowa, F. J.
Paraffin wax	2,045,922	6/30/36	Pevere, E. F.
Petrolatum	1,934,043	11/ 7/33	Davis, G. H. B.
Polyesters	2,380,305	7/10/45	Gleason, A. H.
Propylene	2,190,918	2/20/40	Goethel, H., Tramm, H. and Schaller, P.
Rapeseed or perilla oil	2,158,389	5/16/39	Towne, C. C.
Rubber	2,049,019	7/28/36	Pier, M., Christmann, F. and Donath, E.
	2,199,352	4/30/40	Towne, C. C.
Styrene	2,072,120	3/ 2/37	Mikeska, L. A. and Fulton, S. C.
	1,998,350	4/16/35	Wulff, C., Moll, F. and Breuers, W.
Vinyl compounds	2,020,714	11/12/35	Wulff, C. and Breuers, W.
	2,307,885	1/12/43	Gleason, A. H.

c. Reaction and Condensation Products

STARTING MATERIAL	U.S. Patent	Date	Inventors
Benzene and ethylene dichloride	2,072,107	3/ 2/37	Fulton, S. C. and Mikeska, L. A.
Butylene and diolefin	2,356,127	8/22/44	Thomas, R. M. and Sparks, W. J.
Chlorinated paraffin wax and calcium or sodium	2,350,562	6/ 6/44	Lieber, E. and Hodges, C. E.
Cracked gases and halogenated decahydronaphthalene	2,167,064	7/25/39	Dietrich, M. A.
Dimerized vegetable fat acids and glycol	2,424,588	7/29/47	Sparks, W. J. and Young, D. W.
Ethylene and 2-pentene	2,327,705	8/ 4/43	Frolich, P. K. and Kellog, H. B.
Ethylene and a polyalkyl phenol	2,336,195	12/ 7/43	Sparks, W. J. and Rosen, R.
Ethylenic acid and a secondary amine	2,412,557	12/17/46	Blair, C. M. Jr.
Glycol and alkyl succinic acid	2,394,909	2/12/46	Gleason, A. H.
Hydrogenated rubber and phosphorous sulfide	2,316,085	4/ 6/43	Kelso, C. D. and Mixon, L. W.
Isobutene and chloroprene	2,259,934	10/24/41	Huijser, H. W. and De Nooijer, C. N. J.
Isobutylene and tung oil	2,296,315	9/22/42	Sparks, W. J. and Field, D. C.
Linseed oil and an aromatic sulfonic acid or metal salt of an inorganic acid	2,213,943-4	9/10/40	Auer, L.
Methylpentadiene polymer and maleic a.hydride, formic acid, lauryl amide or styrene	2,422,278	6/17/47	Young, D. W. and Calfee J. D.
2-Methyl-1,3 pentadiene, p-toluenesulfonic acid and phosphorus pentoxide	2,406,575	8/27/46	Young, D. W. and Hineline, H. D.
Naphthenyl ketone and butadiene	2,399,817	5/ 7/46	Meyer, R. E.
Olefins and diolefins	2,109,722	3/ 1/38	Frolich, P. K.
Olefins, diolefin and benzoyl peroxide	2,380,304	7/10/45	Gleason, A. H.
Oleic acid and glycerol or sorbitol	2,152,683	4/ 4/39	Eichwald, E.
Polyhydroxy alcohol and 12-hydroxystearic acid	2,123,641	7/12/38	Wiezevich, P. J.
Rubber, metal halides and halogen acids	2,086,399	7/ 6/37	Towne, C. C.
Rubber and thio-beta-naphthol	2,132,847	10/11/38	Dietrich, M. A.
Styrene, coumarone or vinyl esters in the presence or absence of hydrocarbons	2,421,082	4/27/47	Pier, M. and Christmann F.
Synthetic high molecular weight products	2,018,871	10/29/35	Pier, M.
Unsaturated acid and unsaturated aliphatic alcohol	2,384,595	9/11/45	Blair, C. M. Jr.
Unsaturated polymeric hydrocarbon and tertiary butyl hypochlorite	2,276,956	3/17/42	Gleason, A. H. and Sparks, W. J.
Wax-substituted aromatic hydrocarbon and a dicarboxylic acid halide	2,275,447	3/10/42	Lieber, E. and Mikeska, L. A.

Above — Agitators for Acid Refining of Lubricating Oils in the Pratt Works of Socony-Vacuum, Long Island City, N. Y. Each has 1000-barrel Capacity.

should be non-viscous, should possess high flash and boiling point and should meet all the important lubricating oil specifications like oxidation stability, non-corrosiveness, etc. No such substance has yet been developed for commercial use but this does not preclude the possibility of its appearance on the market some time in the future.

The viscosity index improvers and pour point depressants are both high molecular weight components. For this reason it might be expected that they would be to a certain extent similar in their actions on the oil. Actually it is not always possible to draw a sharp dividing line between these two types of additives which does not mean, however, that all pour point depressants are capable of improving the viscosity index and that all viscosity index improvers have the pour point depressant properties.

A large number of substances has been recommended as viscosity index improvers. This is illustrated by the information presented in Table 6 (see above). The best known commercially are Santodex, Paratones and Acryloids. Paratone CX-2 and Acryloid HF are particularly recommended for hydraulic and gear oils. Physical properties of some of these viscosity index improvers are given in Table 7.

TABLE 7
Physical Properties of Santodex and Paratone

PROPERTY	Santodex	Paratone
Gravity, °API	25.9	29
SUV at 100 °F.	30,000	42,000
SUV at 210 °F.	1,900	3,000
Color, ASTM	2½	3½

The quantity of viscosity index improvers to be used for preparing oils of various viscosities and viscosity indices can be approximated from graphs. One of such graphs developed for Santodex is shown in Figure 1[3]. Its practical application may be visualized from the following example.

Assume that the lubricating oil fractions to be blended with Santodex have a viscosity index of 75 and that the product must have a viscosity index of 105 and Saybolt Universal viscosity at 130° F. of 100. Viscosity of the base oil at 130° F. and the concentration of Santodex in the blend is then calculated as follows:

1) Locate point on graph representing 100 Saybolt Universal seconds and 105 viscosity index as at "a".

2) Since this point does not fall upon existing graph curves, sketch in a curve similar to adjacent curves as "a" - "b".

3) Follow curve downward to a point corresponding to 75 viscosity index as at "b" (horizontal projection from viscosity index scale).

4) Project vertically downward from point "b" to Saybolt Universal viscosity scale. The indicated viscosity of 85 seconds at 130° F. is that required from the base oil.

5) Count the whole and fractional number of sectors (spaces between radial lines) separating point "a" and "b" —in this example 1.0 sectors. Since each sector represents a concentration of 2 percent Santodex a concentration of 2 percent of this viscosity index improver is indicated (1.0 × 2). This concentration should be used in the first trial blends.

6) Possible maximum deviation from the concentration of Santodex, as determined above, is obtained from the "Deviation" graph (lower right of figure) as follows:

a. Project vertically from 2.0 on the horizontal "percent Santodex" scale through the crosshatched area.

b. The intersections of this projection with the upper and lower boundary lines of the crosshatched area show the possible range of concentration that may be required (vertical percent Santodex scale), in this example 2.2 and 1.8 percent.

The graph may also be used for estimating viscosity index and viscosity of base oil of known characteristics after blending it with a fixed quantity of Santodex. Assume, for instance, that 2 percent Santodex are added to an oil having a 75 viscosity index and Saybolt Universal viscosity of 85 seconds at 130° F. Properties of the blend are calculated as follows:

1) Locate point corresponding to 75 viscosity index and 85 Saybolt Universal viscosity at 130° F. as at "b".

2) Follow curve upward across 1.0 sectors to point "a".

3) The coordinates of point "a", namely 105 viscosity index and 100 Saybolt Universal viscosity at 130° F. are the corresponding properties of the blend.

TABLE 8
Agents Recommended for Treating Oils to Improve Their Viscosity Indices

TREATING AGENTS	U.S. Patent	Date	Inventors
Lauryl chloride and aluminum chloride	2,32[illegible],357	7/13/43	Brown, J. H. and Goheen, G. E.
Olefines and hydrogen fluoride	2,378,762	6/19/45	Frey, F. E.
Oxidation and hydrogenation	2,370,228	2/27/45	Bruun, J. H. and Hicks-Bruun, M. M.
Partial oxidation	2,070,567	2/16/37	Adams, C. E.
	2,070,627	2/16/37	Shoemaker, B. H.

Viscosity index improvers may also be introduced into an oil by chemical treatment. Examples of the recommended procedures are shown in Table 8. However, to the writer's knowledge none of them have yet found commercial applications.

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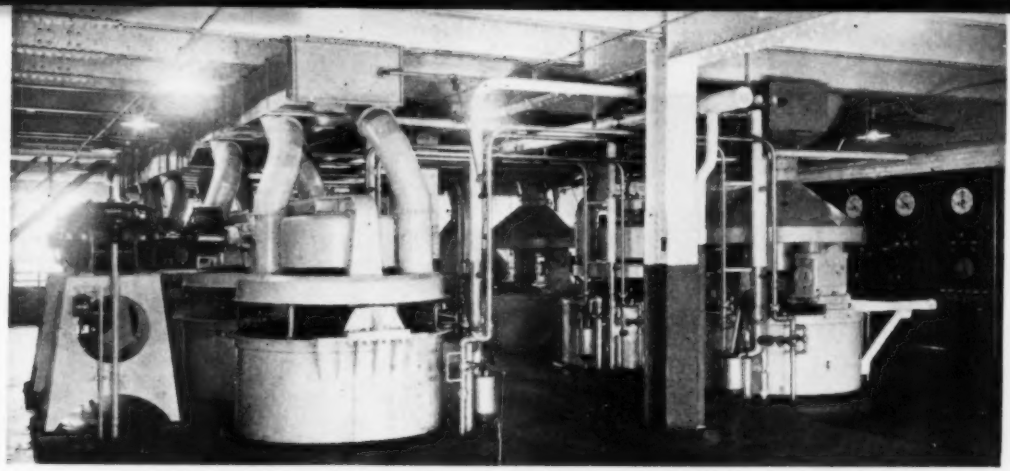

Figure 1. Grease Mixers and Control Panel. (Photo courtesy Imperial Oil Company, Ltd.)

The Manufacture of Lubricating Grease

PART V. LITHIUM BASE AND MISCELLANEOUS LUBRICATING GREASES

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A SERIES of patents issued to Earle on March 3, 1942[2] covered the use of lithium soaps in the manufacture of lubricating greases. At about the same time it was found that such lubricants could be made from low cold test oils so that they were especially adaptable for use as low-temperature aircraft lubricants. The temperature encountered by aircraft at extreme heights is as low as minus 67° F. so it is very important that lubricants be available which will permit functioning of controls under such conditions. Properly formulated lithium base lubricating greases not only met such conditions but also had melting points in excess of 300° F. and were comparatively waterproof.

Recent Development

This type of lubricant, using still different oil blends, was also found suitable for other uses by the armed forces so that little immediate thought was given to other applications. Since that time considerable development work has taken place and now lithium-base lubricating greases are offered for industrial uses and multi-purpose lubrication. The increased interest in this subject is evidenced by the fact that more than 40 patents have been issued for the use of lithium soaps in lubricating greases since 1942. In spite of the fact that lithium hydroxide costs about $1 a pound and thus lithium lubricating greases demand a premium over older types, several million pounds of the lithium type are now being marketed annually.

Of Plastic Nature

The product is of a plastic nature and can be produced with a clarity approaching that of aluminum soap lubricating greases. If properly formulated and processed, lithium-base lubricating greases can be prepared which are stable against working. The particular fatty acids used for the manufacture of the lithium soap as well as the type of mineral oil and procedure in manufacturing are all factors in producing work stable lubricants.

Lithium-base lubricating greases can be prepared by either batch or continuous processing, but the proportion made by the latter procedure is rather small. Since temperatures in the range of 400° F. are required for dispersion of lithium soaps, modifiers are sometimes added to reduce the temperature of processing. One procedure claims to manufacture these lubricants at about 300° F.

Batch Formation of Lithium-Base Greases

Lithium-base lubricating greases can be prepared from either preformed soap or from soap prepared in situ. The former is the simplest procedure as well as the most rapid. For either procedure a kettle with provision to attain temperatures of 400° F. is required. Fire heated kettles are almost universally used for this purpose, although circulation of a heating medium, such as Dow-therm, in a jacket will also serve. It is desirable to have two or more speeds on the agitators and if the product is to be kettle finished, double agitation with at least a 25-hp. motor or heavier should be provided.

When using preformed soap, which is normally lithium stearate, the soap

THIS IS THE fifth and final part of a series by Mr. Boner who thus finishes his review of present day grease-making practices. The series, which started in the March issue of PETROLEUM REFINER, has discussed in consecutive installments, introduction to the manufacture of lubricating grease, processing equipment for grease manufacture, calcium and soda-base greases, aluminum and barium-base greases and this fifth part, lithium-base and miscellaneous greases.

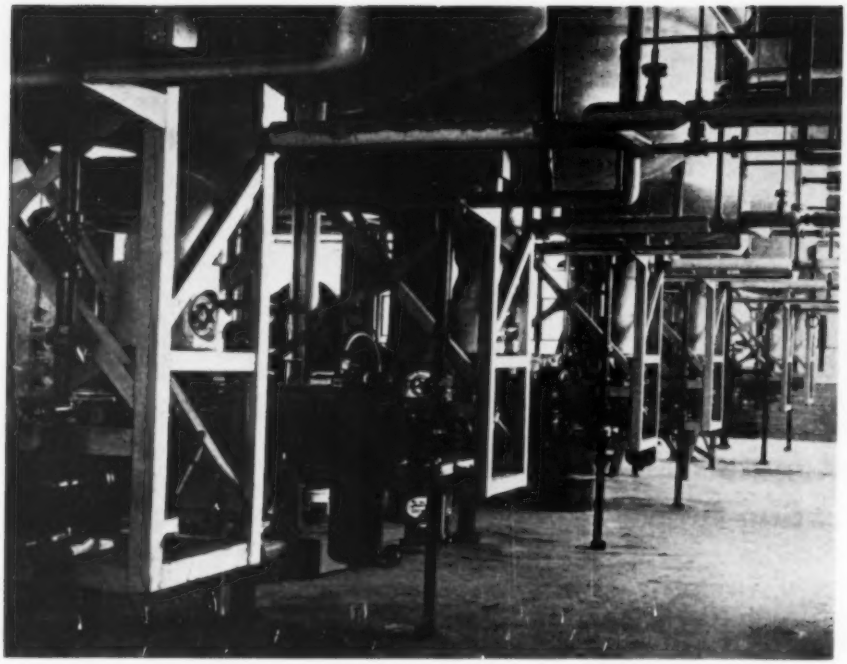


Figure 2. Outlets from Grease Kettles Showing Strainers. (Photo courtesy, Sinclair Refining Company.)

and a portion of the mineral oil are charged and the mass beaten into a slurry before heat is started. After the fire is started foaming may occur if the soap has excess moisture, but once a temperature of 230° F. is passed, heat can be applied as rapidly as desired and additional oil added at will. Additives or modifiers can also be added after the moisture has been removed. At a temperature of about 350° F. the mass will go into a gel stage and start to "heavy up" so that agitation may have to be shifted to low speed. At about 375° F. this will become a viscous fluid and finally at about 390° F. will be entirely fluid. If the material is to be discharged from the kettle as a fluid the temperature is carried 10 to 15 degrees higher before turning off the heat.

Discharge by Gravity

At this stage the product is ready to discharge into pans. This can be done by gravity, if the kettle and pans are properly located, or can be pumped if necessary. In the latter case the pump should be jacketed and the pipe lines traced with either steam lines or electric heater strips. The pans used for cooling are similar to those used for cooling aluminum-base lubricating greases, except that for the former product only welded pans are permissible due to the high heat to which they are subjected. As soon as the panned material is cool enough to handle the pans can be emptied and the product milled.

If the lithium soap is to be prepared in the kettle the fats and fatty acids together with a solution of the required amount of lithium hydroxide are charged and mixed. Heat is then started and when most of the water has been removed oil can be slowly added in a small stream. It is best to make a titration of the soap to be sure that it is neutral or slightly alkaline. The above procedure will take some three or four hours and increase the cycle of a charge at least two hours over one made from preformed soap. After the charge is dry and neutral the procedure for finishing is the same as described above.

It is possible to finish lithium-base lubricating grease in the kettle and thus do away with the panning operation. If this is to be done the procedure is as above except that only half of the total oil is added to the kettle and the temperature raised to 390° F. so that the soap is entirely dispersed. The mass is then cooled below the gel point and for this purpose a jacket in which water can be introduced is convenient. After the mass has cooled to the gel point, approximately 350° F., more oil is started in and added as fast as it can be mixed. During this procedure the mixture becomes very heavy and thorough mixing is desirable. By the time all of the oil has been added the temperature should have dropped to about 200° F. at which point the lubricant can be screened and packaged. While a time cycle for a charge put in pans will be about six to eight hours, the cycle for a batch finished and packaged from a kettle will be about ten hours.

A series of patents[1] issued to Ashburn and co-workers state that by the use of lithium soap of hydroxy stearic acid together with lithium soaps of saturated fatty acids, formed in mineral oil, dehydration can be accomplished at temperatures not exceeding 300° F. and the final oil then added. Such lubricants are said to be stable as to working but it appears that the soap percentage to obtain a given consistency is higher than if the soaps were dispersed at higher temperatures.

Continuous Formations of Lithium-Base Grease

Lithium base lubricating greases can be prepared in a continuous stream by the same procedure as is being used for the manufacture of aluminum-base lubricating greases (see Part IV, PETROLEUM REFINER, June, 1949). A slurry of the lithium

soap, any additives or modifiers desired, and the mineral oil is prepared and fed to concentric cylinders where the heating medium is Dow-therm so that the temperature of the stream can be raised to 400° F. This hot stream then passes to a cooling cylinder where a water jacket reduces the temperature to 210° F. Houlton and co-workers[5] state that two minutes in the heating zone is sufficient and that following the cooling cylinder, provision should be made to hold the mass for a gelling period of 10 to 20 minutes. Following this dormant period the product is milled and packaged. The total time from the start of the slurry in the system until the finished product is taken out is about 20 minutes. The advantages of such a process are that due to the closed system there is no fire hazard, less handling of the product is required and a closer control of operating variables is possible. However the process does require careful and constant attention. On the other hand the batch process will permit variations in the fatty acid constituent of the soap which is not possible with the continuous process.

Strontium-Base Lubricating Grease

Since the soaps of the alkaline earth metals calcium and barium had been found valuable for the production of lubricating greases it seemed reasonable that soaps of other metals of the same periodic series should be investigated with a similar use in mind. The outgrowth of such work was disclosed in an article on "Strontium Greases" by Worth and McLennan[7] published in July 1947. They stated that such lubricants were being regularly manufactured and marketed for special industrial applications. One of their first problems was to obtain a reliable, regular supply of strontium hydroxide which was not available when they started their development work.

Preparation of strontium soaps and the corresponding lubricating greases is carried on in much the same manner as with barium-base products. Thus a vessel with good agitation, plenty of power and heating capacity to reach a temperature of 500° F. is required. Either the basic or the complex soaps can be used and lubricating greases containing both types of soaps are being produced.

A typical procedure in the manufacture of a basic product is to charge cottonseed oil or tallow with a small amount of sperm oil, together with sufficient strontium hydroxide to provide two chemical equivalents for the above fats. After mineral oil equal to half the volume of fats has been added the mixture is heated and agitated until a temperature of about 300° F. is reached, at which point the normal strontium soap has been formed. Further oil is then added and the charge is heated to 500° F. for 8 to 12 hours, by which time the free base has been taken up and the basic soap formed. While the final product will be substantially anhydrous, the structure can be improved by cooling to 210° F., adding about 3 percent of water and then raising the temperature to 250° F. to dehydrate. Likewise the grease structure can be improved by milling the product at a temperature below 200° F. Before packaging the temperature should be reduced to 150° F.

For the production of a complex soap tallow fatty acids and acetic acid are charged, together with strontium hydroxide and mineral oil. The final heat in this case is carried to 450° F., after which the charge is cooled and milled. In still another case the complex soap is formed by charging as above and after the initial reaction, carbon dioxide is bubbled through the charge so that it will combine with part of the strontium hydroxide leaving strontium carbonate as a constituent of the complex soap.

The basic strontium lubricating grease is buttery in texture, while the complex type is fibrous. The other characteristics are similar for the two types and may be listed as: ability to retain the same structure after repeated heating and cooling; ability to resist the emulsifying and disintegrating effects of water; unusual stablity when subjected to mechanical working; and melting points up to 450° F. Thus they are particularly valuable where lubrication at high temperatures is desired.

Lubricating Greases of Miscellaneous Soaps

Many attempts have been made to use soaps of metals other than those listed in this series of articles, to pro-

Figure 3. Traveling Weigh Tank for Caustic Soda Solution Used in Charging Grease Kettles. (Photo courtesy Sinclair Refining Company.)

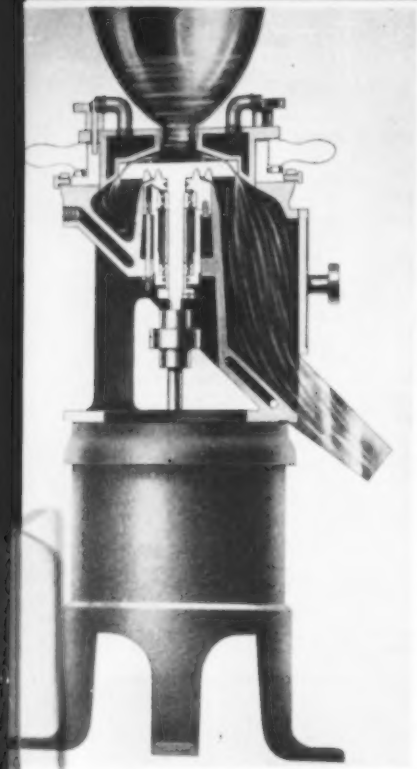


Figure 4. Colloid Mill for Dispersing Fillers in Lubricating Grease.

duce lubricants. While none of these are of major importance at the minute, notation will be made of some which have been so used.

With the advent of the hypoid gear in automobiles a fluid lubricant to resist sliding friction as well as friction from rolling action was required. It was found that oils containing both active sulfur and lead soap filled this requirement. The lead soaps used had little thickening power, in fact in some cases such soaps settled out of the oil, so that what resulted was a fluid lubricant. The above combination has been largely superseded by other additives containing chlorine, sulfur and phosphorus compounds. However, some specifications still call for the use of lead soap together with other soaps to give body.

Zinc soaps are similar to lead soaps in that they do not stay suspended in mineral oil and contribute no thickening, but they are used to some extent to contribute waterproofness.

Magnesium soaps will thicken mineral oils to give a clear jelly-like product but since the melting point is low it has not met with much favor.

Soaps of many other metals have been experimented with as bodying agents for mineral oils and two patents even call for the use of silver soaps.

Likewise, claims are made for numerous mixtures of soaps, some patents calling for the use of soaps of four different metals in the same lubricating grease. No substantial tonnage of such lubricants are encountered.

Inorganic Fillers

Inorganic fillers, consisting of finely divided solids, are added to lubricating greases in amounts up to 50 percent in some cases. The filler most often encountered is graphite, normally used to the extent of about 5 percent by weight. Lubricating greases containing zinc oxide are also frequently encountered. Other fillers employed are asbestos, magnesium oxide, titanium dioxide, mica, carbon black, fine silica, powdered lead, powdered zinc and red lead.

Most fillers are added after the grease structure is formed and some of them can be added to the kettle used for finishing the product and mixed with the regular equipment. Others may have to be milled in by the use of modified paint mills or even equipment akin to colloid mills, such as that shown in Figure 4.

Organic Fillers

Organic fillers are now seldom encountered but there is still a very small demand for lubricating greases thickened with wool waste, wool yarn or horse hair. The latter ingredient is added to one of the former two so that a more resilient product results. The function of these materials is simply a carrier for lubricating greases with which they are saturated.

Synthetic Diluents

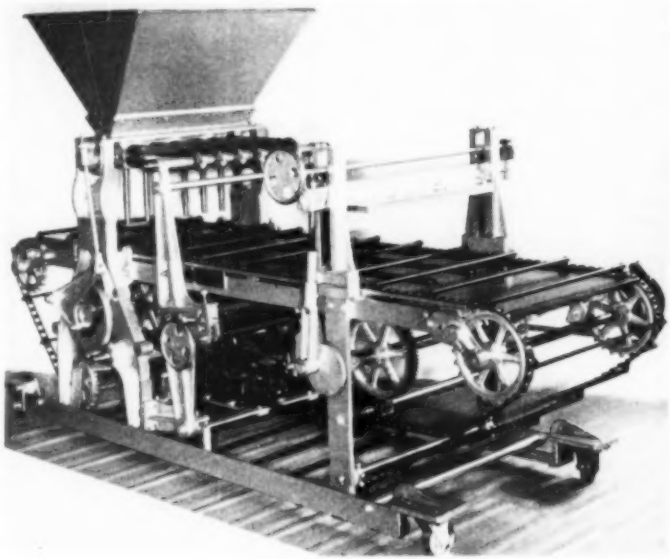
In attempts to provide liquids which would be satisfactory lubricants and overcome some of the deficiencies of mineral oils a number of synthetic products have been suggested. As soon as such a liquid showed promise as a lubricant attempts were made to provide a lubricating grease made from the same. While none of these special products have gone beyond the specialty stage and are still being sold in small volume, they are worthy of note. All such products have been dveloped in the last few years. To date all of these synthetic diluents are more expensive than mineral oils.

Silicone Lubricating Greases

About six years ago a "plug cock" grease was offered which consisted of a silicone liquid thickened with finely divided silica. At that period the silicone liquids available were not too satisfactory as lubricants, but soon others appeared which would serve for low speed bearings. Lubricating greases made from these latter liquids, by thickening with carbon black, were satisfactory for slow speed bearings. Recently silicone lubricating greases have appeared which are suitable for use in bearings with speeds up to 20,000 rpm. and at temperatures ranging from minus 40 to 300° F.

These latter lubricants are soap-thickened liquids, lithium soap being normally employed as the thickener. Since soaps do not disperse in such

Figure 5. Filling Machine Used for Small-Sized Containers of Lubricating Grease.



liquids as they do in mineral oils, special procedures are required to obtain grease structures. Hain and Zisman[3] accomplished this by taking a petroleum fraction boiling below 400° F. and by heat forming a solution of lithium soap. To the solution thus obtained a silicone fluid was added which was miscible with the petroleum fraction. The petroleum fraction was then removed by evaporation so that a dispersion of lithium soap in the silicone fluid remained.

Silicone lubricating greases are said to be more heat stable than those made from petroleum oils, very resistant to oxidation and inert to water. They also have a very low viscosity temperature change and are nontoxic.

It is of interest that the current price of silicone lubricating grease is about $7. per pound.

Polyalkylene Glycols

At an SAE Meeting in January, 1946 Kratzer and co-workers[6] gave details of a series of synthetic lubricants which had been subject to an order of secrecy during the late war. These consisted of polyalkylene glycols and derivatives which had been used for aircraft engine lubrication and brake fluids.

The characteristics of such fluids which should make them valuable in lubricating greases are that they remain fluid at low temperatures, do not form sludges and gums like petroleum oils under ordinary conditions of use, have a low change in viscosity with change in temperature and have a low carbon residue. Since they are polymers they can be prepared in any viscosity desired.

While some lubricating greases have been made from the above fluids over the past three years, they have not been offered widely.

Esters

Many organic esters have been investigated to determine their value as diluents in lubricating greases. The Naval Research Laboratory[4] were particularly active in this field and prepared a series of lithium base lubricating greases from the 2-ethyl-hexyl diesters of sebacic, azelaic and adipic acids and from di-tetradecyl sebacate.

These lubricating greases were prepared in much the same manner as similar products in which mineral oil is used, i.e., a fire-heated kettle was used and the temperature raised to 400° F. The mass was then cooled in a static condition after which it was milled to obtain a finished product.

These esters gave particularly satisfactory lubricating greases for use at low temperatures and at the same time had a low volatility up to 210° F. As a consequence an instrument grease and a low-temperature aircraft grease are being supplied to the government, both containing some of these esters. These are used in a temperature range from minus 90 to 210° F. Other desirable characteristics of such products are their non-corrosiveness and high oxidation stability.

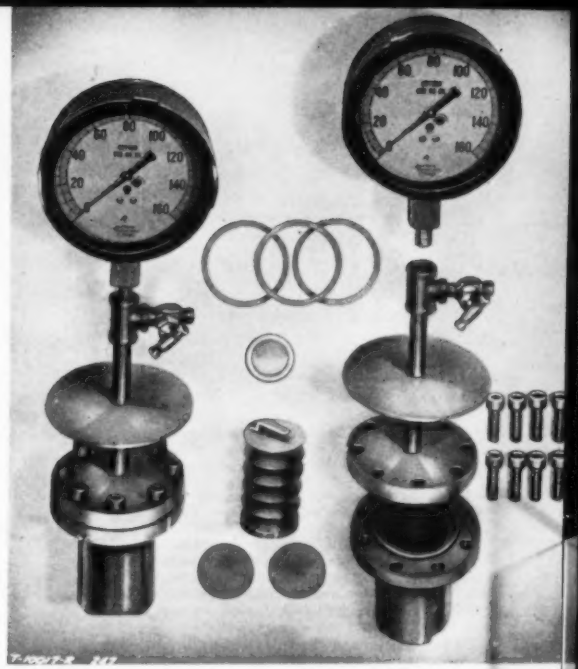


Figure 6. Apparatus for Oxygen Absorption Test of Lubricating Grease.

Other suitable esters are available and will no doubt take their place with those above in lubricating greases. Of course mixtures of esters are used as well as mixtures of esters and silicones or other diluents.

Synthetic Hydrocarbons

The author does not know of the use of synthetic hydrocarbons for the manufacture of lubricating greases in the United States but undoubtedly such application was made in Europe during the late war. Our technique could undoubtedly be adapted to such use if necessary.

Fluo-Lubes

For the past two years two or three firms have been manufacturing perfluorocarbon compounds on a limited scale. Some of these products are liquids suitable for lubricants and since they are chemically and thermally stable, they have applications where conditions of use are drastic. These perfluoro-lube oils are stable chemically and thermally at temperatures below 500° F. They have specific gravities of 1.9 to 2.1 but have a poor viscosity index. They are insoluble in all the common organic solvents including aromatics and chlorinated products. These compounds will not burn and are resistant to the action of concentrated nitric acid, fuming sulphuric acid, mixed acids used for nitrating, strong oxidizing agents such as acid chromate and permanganate, chlorine, hydrogen fluoride and caustic soda at temperatures up to 100° C. They are attacked only by such reagents as metallic sodium and potassium at 200° F. and by fluorine at lower temperatures.

Small quantities of perfluorocarbon lubricating greases have been produced recently which have the same chemical stability as the perfluorocarbon lube oil. The liquids are quoted at $60. per pound and advice has been received that the lubricating greases will be even more expensive; therefore, the use will be restricted for the present.

Conclusion

In view of the recent developments noted above, it is readily apparent that the manufacture of lubricating greases is not static and that the industry is trying to supply the most satisfactory products for all of the various demands.

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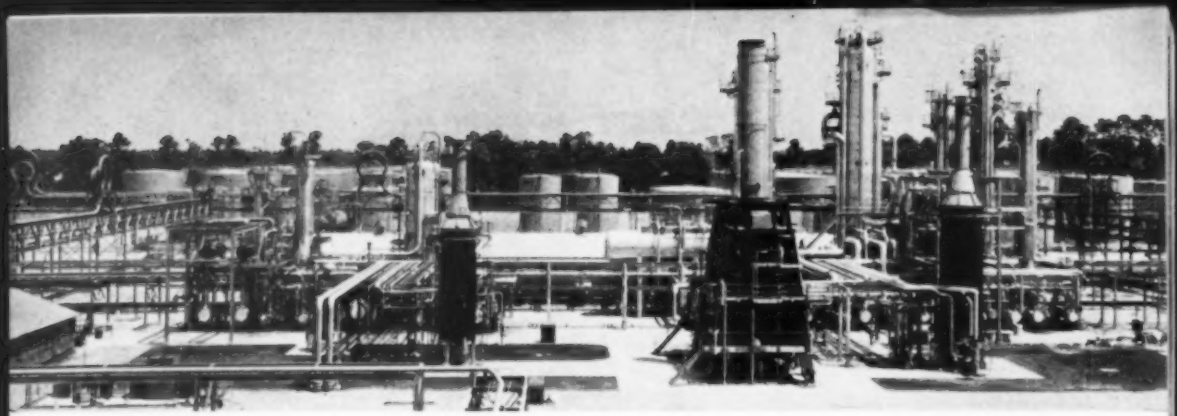


Propane Deasphalting and Phenol Extraction Units, Constructed as One Combination Unit for the Shell Oil Company's Deer Park Refinery near Houston.

New Combination Lube Oil Unit Built at Deer Park

THE new facilities which Shell Oil Company has installed at its Deer Park refinery near Houston include units for lube oil distillation, propane deasphalting, phenol extraction, and lube dewaxing. Two of the units, the propane deasphalting step and the phenol extraction step, have been constructed as one combination unit.

The propane deasphalting unit processes 4500 barrels per day of reduced crude, the residue of a vacuum distillation operation. Through the aid of propane, asphalt, resins, undesirable color-bearing and high-carbon-bearing bodies are removed from this reduced crude and its viscosity index improved.

The finished product from the propane deasphalting unit becomes part of the feed to the 5800-barrel-daily phenol extraction unit, along with certain additional fractions from other units in the refinery. Here phenol operates as a solvent further to refine the lube by dropping out aromatics and lacquer-forming bodies.

The two units, designed by The M. W. Kellogg Company, were laid out in four rows.

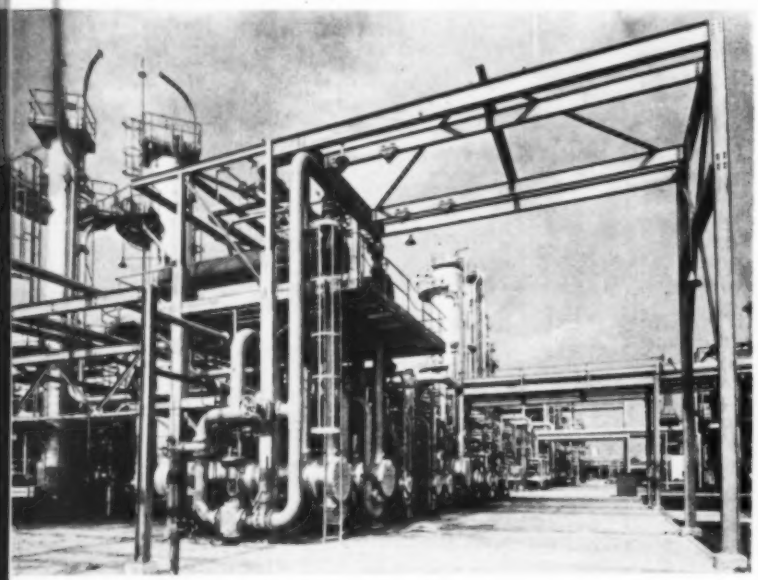
Nearest the camera, photo at top of page, is a row of three furnaces. Immediately behind it is the exchanger row. Next comes the tower row, and at the rear are the two pump houses separated by a combination control room. This over-all planning makes for ease of construction and ease of servicing.

A wide service alley, designed for the use of trucks and tractors, separates the exchanger section from the furnace section. It permits easy pulling of tube bundles during turnarounds. The elevated exchangers are provided with monorails and trolleys for additional maintenance convenience. Platforms have been installed on all towers and furnaces to make valves, manholes and outdoor instruments easily available. These platforms are provided with steam, air and water service connections.

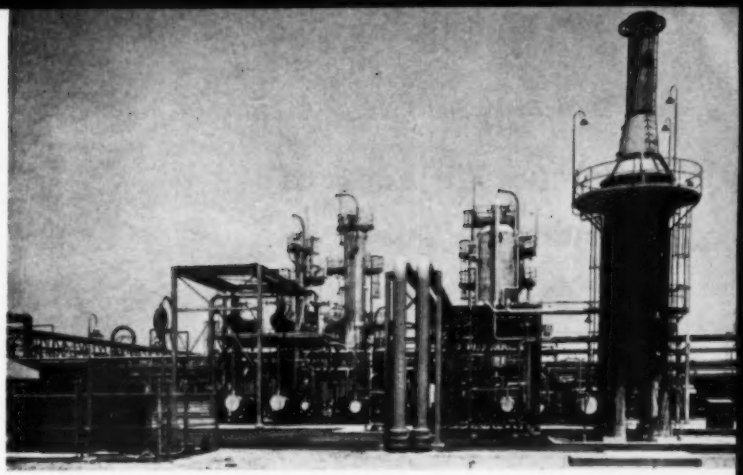
Piping used on refining installations of this kind amounts to 25 percent of the cost of the whole plant. In this Shell lube plant there is no buried piping anywhere in the plant, except the sewer lines. This eliminates a number of problems of corrosion which would have resulted due to the corrosive nature of the soil in the Houston area, and provided "a desirable, visible arrangement, ideally suited for ease of inspection, servicing and replacement." The piping is all carbon steel, the maximum diameter being 18-inches (for the main water lines).

The overhead piping is supported in several layers or banks by steel beams, with a minimum clearance of 10 feet. All valves higher than 6½ feet from ground, which cannot be conveniently operated by hand, are provided with chain wheel operators.

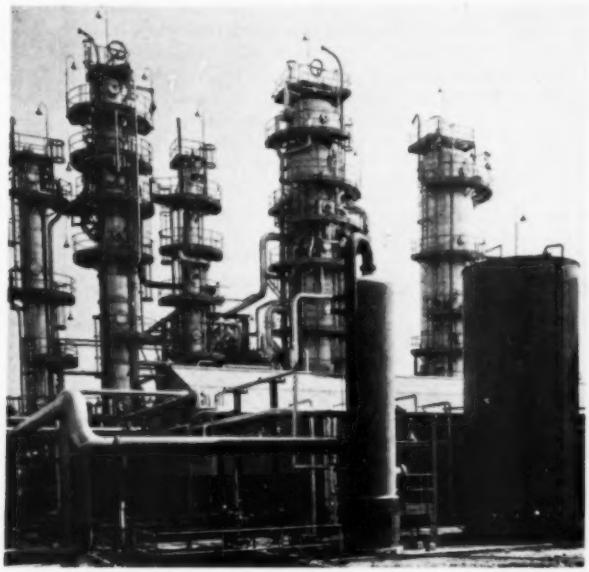
All insulated piping and other equipment outdoors is aluminum-jacketed and liberal uses of aluminum paint has been adopted in the rest of the plant. All exposed steelwork is galvanized in-



Exchanger Section of the Combination Phenol Extraction and Propane Deasphalting Unit. Photograph shows the wide service alley separating the furnace row from the exchanger row. For ease of construction and maintenance, this unit was laid out in 4 parallel rows, the other two being a tower row—several towers are visible—and an exterior row made up of the two pump houses separated by a combination control room. The service alley is paved and is used by trucks and tractors in pulling of tube bundles during turnarounds. Elevated exchangers are provided with permanent monorails and trolleys. Exchangers in the foreground are propane condensers; tower at far left is asphalt stripper; immediately to its right is the deasphalted oil stripper; the first tall "fat" tower in the background is the phenol treating tower.



Propane Deasphalting Section of Shell's new combination lube unit. The "fat" tower in the background at the right is the propane treating tower, a shop-fabricated, 150-ton vessel approximately 50 feet high by 11 feet in internal diameter and designed for pressure service in the range of 500 psig. The furnace at the right is a cylindrical shell, vertical tube type for heating the asphalt solution bottoms of the treating tower, prior to stripping off the propane from the asphalt. This latter stripping operation is conducted in the small tower at the extreme left of the group of three. The middle tower is the deasphalted oil stripper in which propane is removed from the refined overhead of the treating tower. The furnace row, exchanger row, tower row and pump house of this unit are in line with corresponding rows of the phenol extraction section (out of the picture at the right).



The phenol extraction section of the combination lube unit, shown at the left, consists of five towers. These include (a) treating tower, where oil feed from the propane deasphalting section or from the vacuum distillation unit is initially contacted with phenol; (b) phenol tower, which removes phenol from the extract solution (bottoms of phenol treating tower); (c) extract stripper; (d) raffinate tower (combined with raffinate flash stripper) and (e) absorber tower.

cluding all bolts and fastening members.

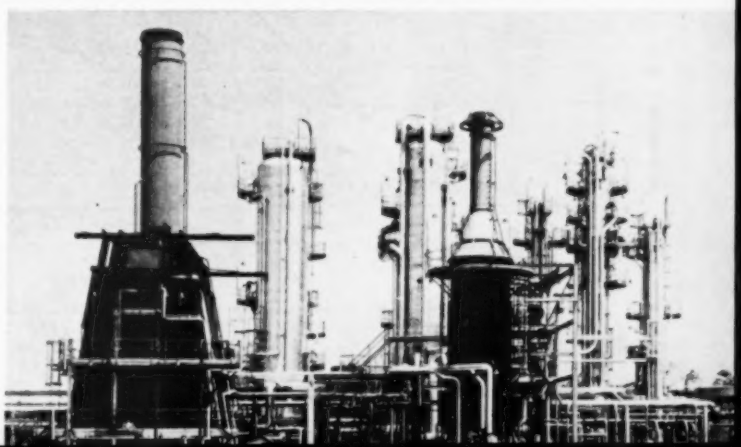
The A-frame furnace, used in the phenol extraction plant, is designed in the form of a block A which reduces the area of the non-useful end walls (which are not hung with tubes) and thereby eliminates dead space and corner "pockets," improves efficiency, reduces the size of the furnace and saves money through reduced use of steelwork and construction manhours without sacrificing heat transfer.

In operation, this furnace, a Kellogg development, is very quiet. The design temperature of 1740° F.—generated from the combustion of natural gas flowing through dozens of gas burners in the floor of the furnace—is rarely approached in actual operations. The oil solution—some 15,000 barrels per day—passes through horizontal pipes hung on the inner face of the side walls. It exists at a temperature of about 550° F. due to heat transfer through the walls of the pipe caused by radiant and convection heat from the fire and reflection of heat from the walls.

In the A-frame design, all trusses are eliminated and the main furnace columns actually form part of the stack support. This design also provides a high ratio of tube surface area to the volume of the combustion section because the tubes may be so disposed as to keep blank walls and arches to a minimum.

The A-frame furnace is equipped with remotely hand-operated steam-smothering lines to the header boxes and to the furnace combustion chamber, so that in case of a leak ever develops, the resulting fire may be snuffed out with steam by an operator standing safely at a distance.

Left foreground is an A-frame furnace specifically designed to heat 15,000 BPD of extract solution of 550° F. without cracking. Right foreground is a cylindrical-type raffinate furnace which vaporizes phenol from the prime product (raffinate), the overhead from the phenol treating tower. Immediately behind the furnaces is an exchanger row and behind the exchanger row is the tower row.



For Steel Tanks and Pressure Vessels—

Minimum Thickness of Cylindrical Vessels

R. R. MACCARY and R. F. FEY
Process Industries Engineers, Inc., Pittsburgh

IN the design of a cylindrical shell, the thickness obtained for many low pressure applications by use of stress equations are considered too thin not only from a manufacturing standpoint, but also from consideration of the inherent rigidity and stability of the cylindrical form.

The 1944 edition of the API-ASME Unfired Pressure Vessel Code limits the minimum thickness of the cylindrical shell to a value not less than

$$\frac{D + 100}{1000} \qquad (1)$$

in which D is the inside diameter in inches of the shell. Thinner plates are permitted provided the shell is adequately reinforced by structural members. Equation (1) provides practical minimum thickness for horizontal shell diameters not exceeding four feet.

For larger diameters, manufacturing experiences have dictated greater thicknesses to facilitate handling without undue costs. Horizontal shells with plate thicknesses below practical minimums are subject to stresses beyond the yield point of material when loaded by their own weight. To avoid permanent deformations, reinforcing structural members become necessary both during fabication and for the completed vessel.

The majority of horizontal vessels are subject to loads by contained liquids in service. Such conditions also prevail in those cases where vessels are hydrostatically tested in a horizontal position. Bending stresses approach a maximum when the vessel is half filled by contained liquid, causing undesirable deformations where the shell plates are stressed beyond the yield point. Practical minimum shell thicknesses above the limit of Equation (1) have been found necessary particularly in larger diameter vessels.

Vessels containing condensible gases or vapors are subject to external pressure when the ambient temperature decreases. Operational errors in removing the liquid contents without proper venting of vessel has contributed to failures by external pressure in very thin-walled shells. From the considerations of stability of the shell under external pressure and deviations from true cylindrical form encountered in manufacturing, the desirability of limiting the plate thicknesses to practical minimums becomes apparent for safety considerations alone.

Investigations of the relations involved in the aforementioned conditions, combined with practical manufacturing considerations, have contributed to the development of the following satisfactory empirical equation for carbon steel, limiting the minimum thickness to a value not less than

$$\frac{1.75}{Sy} R^2 + .125 \qquad (2)$$

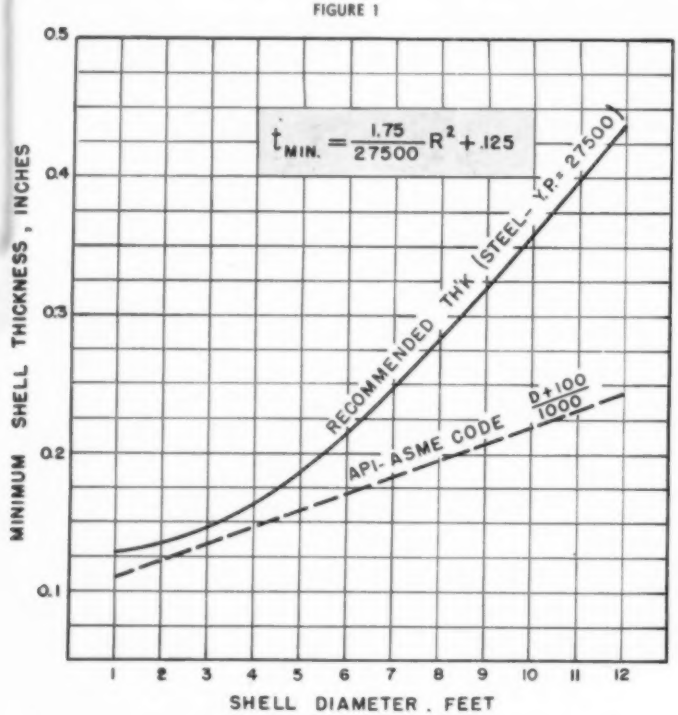
where R is the inside radius of the shell and Sy is the yield point of material. This equation serves to determine the practical minimum thickness of horizontal shells fabricated of carbon steel normally within a range of diameters from 2 through 12 feet.

In Figure 1 comparative curves are shown for Equations (1) and (2), indicating the divergence of values for the larger diameters. The upper curve should be used for calculating practical minimum shell thickness for horizontal pressure vessels.

The minimum thickness of shell plates for vertical vessels involves additional considerations, besides the relation of Equation (2). Such vessels may be divided into two general classifications:

(a) $2D \geq H$ Atmospheric Storage Tanks and Containers

FIGURE 1



(b) $2D < H$ Fractionating Columns, Stacks, etc.

where D equals diameter and H equals height

Vessels of Type (a) proportions are generally subject to only atmospheric pressure or a slight vapor pressure, and are suitable for storage of liquids and solid materials. Type (b) vessels may operate under pressure, vacuum, or atmospheric conditions.

The minimum practical thickness of shell plates for Type (a) vessels have been established by various codes on the basis of practical considerations of manufacturing, rigidity, stability and wind effects. Vessels exposed to wind pressure tend to flatten or assume an oval shape when empty. The minimum thicknesses for such structures are 3/16 or 1/4 inch, depending on size of vessel. Figure 2 represents graphically the shell plate thickness for the bottom course of vessels meeting the requirements of API-standard 12-C for oil storage tanks. These minimum thicknesses are satisfactory for application of tanks containing liquids of specific gravities within the approximate range of oils, and other petroleum products. Vessels containing water should preferably be limited to 1/4 inch as a minimum practical thickness specified by the American Water Works Code.

The minimum thicknesses on the basis of practical considerations of 3/16 inch for vessels 15 feet in diameter, and 1/4 inch for vessels more than 15 feet in diameter, should be considered a design criterion for vessels which are not subject to an appreciable internal pressure such as lift gas holders, etc.

When vessels of Type (b) proportions are exposed to wind pressures, the shell is subjected to bending as a cantilever beam with the base as a fixed end. Such bending of a cylindrical shell introduces the t/D ratio as a consideration of the stability characteristics. Considering a wind velocity of 100 miles per hour and an allowable working stress for steel of 12000 psi., the following relation is obtained which denotes the minimum thickness of the cylindrical shell at which the compressive stresses will exceed the allowable stress.

$$t_{min} = \frac{.0795}{12000} \frac{H^2}{D}$$

where t = shell thickness in inches, H = height of vessel in inches, D = diameter of shell, inches. The graph of Figure (3) reveals the need of larger shell thicknesses as the slenderness ratio increases. Such minimum thicknesses are necessary only for the lower portion of the vertical vessels provided other considerations do not govern for the upper section. The maximum bending stresses occur on the lee side of the vessel with respect to the wind direction and at the base of the vertical cylinder.

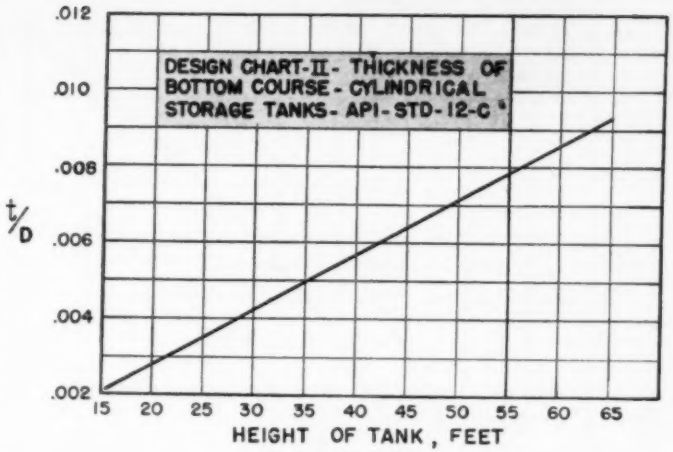
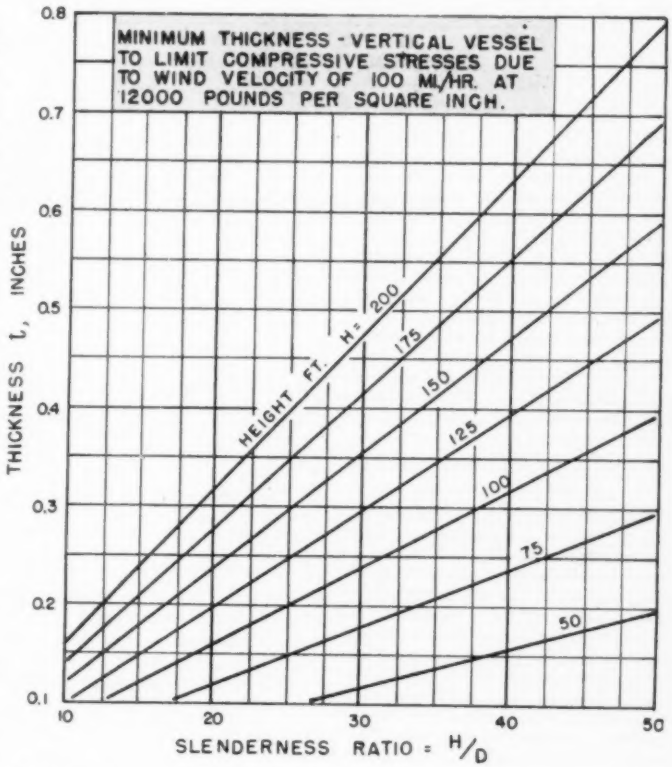


FIGURE 2

Many tall slender vessels, as fractionating columns of chemical and petroleum refinery plants, must be designed to limit the deflections produced by lateral wind loads. Limiting deflection is considered necessary to avoid excessive swaying especially

FIGURE 3



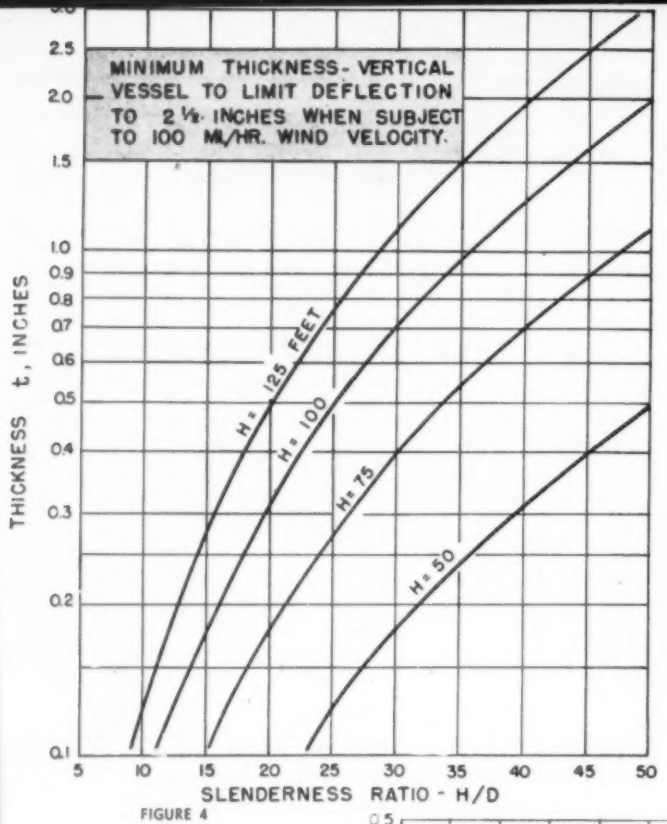


FIGURE 4

where servicing during operation is performed, and also to avoid leakages in piping connections. Flexibility can generally be incorporated in the design of the piping, but connections to vessel are generally rigid in design to assure tightness of joints. Where such piping connections occur, the minimum thickness should be sufficient to limit the deflection to a reasonable value. A 100-mile-per-hour wind will cause a deflection not exceeding a nominable allowable 2½ inches at the top of column provided the thickness is not less than that given by the relation

$$t_{min} = \frac{7.9}{10^5} \frac{H^2}{D^2} \text{ (Average Thickness)}$$

which is plotted in Figure 4. Thin shells, subject to axial compression and bent by wind loadings, may fail either by instability of the shell proper or local distortion of the wall of the shell. The latter type of failure is characterized by wrinkles, circular or lobed in shape, and is dependent upon the geometrical relations of cylinder, its radius and thickness besides end conditions, flaws in materials, irregularities and eccentricities of loading. Investigations conducted on thin cylindrical shells indicate that the critical wrinkling stress for plates ¼ inch or more in thickness will be equal to the yield point of material if the t/d ratio exceeds 0.003. Shells whose thickness diameter ratio exceeds this value can be subjected to considerable localized axial strain without having its load-carrying capacity reduced.

Cylindrical vessels subject to wind loads require that minimum thickness be governed by considerations of stability, which stability may be attained by limiting the t/d ratio to .0035 minimum. Figure 5 graphically represents this relation for design applications. The load-carrying capacity of the cylindrical shell decreases rapidly at stress below the yield point of material for t/d less than .0035. In no case, however, should the minimum thickness of vertical vessel be less than that limited for a horizontal shell Figure 1 particularly if the vessel is to be subjected to hydrostatic tests in horizontal position.

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American Water Works Association standard specification for Elevated Steel Water Tanks, Standpipes and Reservoirs.

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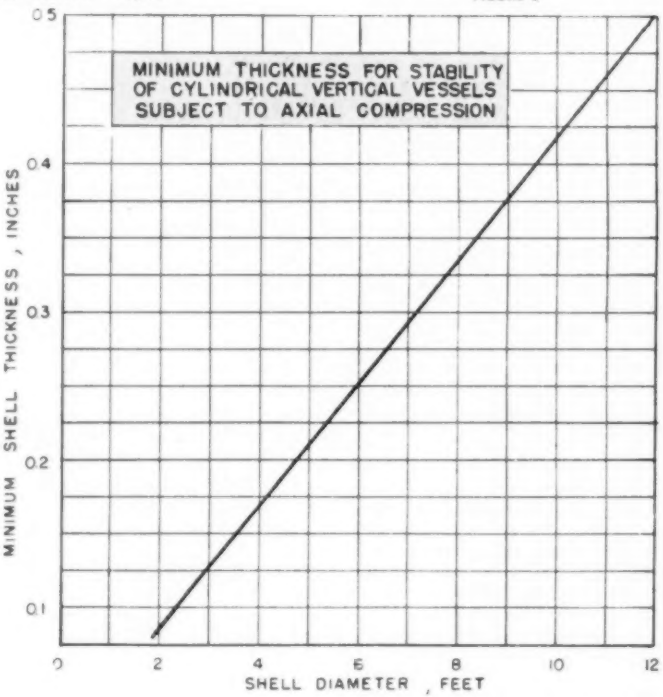
Strength of Thin Cylindrical Shells as Columns, Wilbur M. Wilson, University of Illinois Bulletin 255.

Transactions Am. Soc. Mech. Eng. Vol. 56 1934—L. H. Donnell.

FIGURE 5



***RECOGNIZING** the toxicity of tetraethyl lead, Ethyl Corporation for the last 25 years has worked at developing and improving safe practices for its handling and mixing. As a result the corporation has developed a comprehensive safety program. It is significant that wherever these procedures have been followed, no case of lead poisoning has ever been encountered at mixing installations.*

The author herein outlines the several methods of mixing gasoline with compounds containing tetraethyl lead, together with the recommended procedures which are advocated as sound practice.

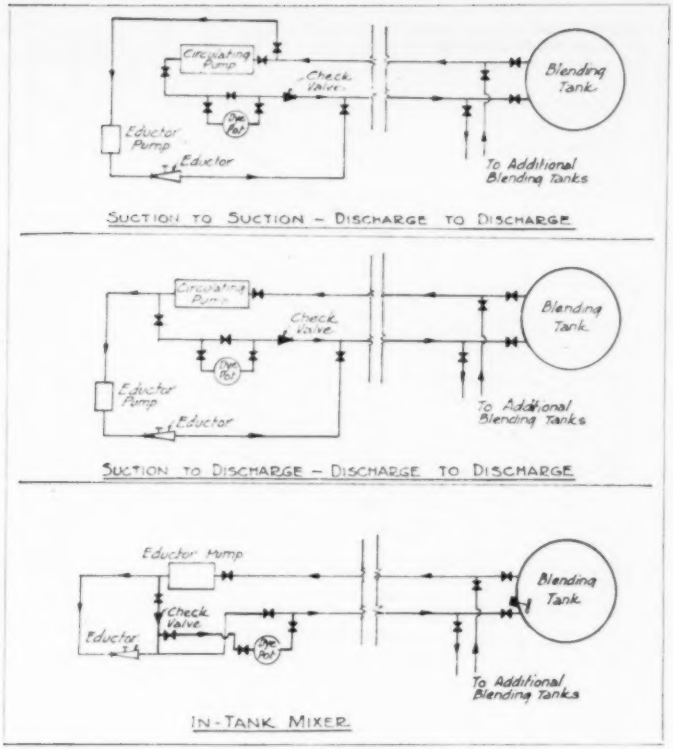


FIGURE 1

Mixing Leaded Gasolines

L. R. FLECK

Ethyl Corporation, New York

TODAY, the great majority of gasolines are improved with antiknock compounds containing tetraethyl lead. Refiners know that they are an economical means of improving and controlling the antiknock characteristics of finished gasolines. One very important factor contributing to their successful use is the comprehensive safety methods which have been developed through the years.

One of the most important requirements is that compounds containing tetraethyl lead be mixed with gasoline only at main distribution centers of refiners of gasoline.

Experience has shown that mixing plant sites should be located away from dwellings and public thoroughfares and at least 50 feet from other buildings such as offices, laboratories, warehouses, etc. The building protects a valuable inventory and special equipment against adverse weather conditions and fire hazards. Further protection from fire hazards is provided by locating the plant at least 100 feet from processing equipment, gasoline storage tanks, loading racks and other comparable fire hazards. If the mixing plant is supplied by rail shipments, the preferred location is at the dead end of a spur track, which is equipped with a bumper and derail. In other locations, the car should be protected from collision and accidental removal.

Because of their physical characteristics, antiknock compounds are unusually difficult materials to transport. It is necessary to provide specially designed shipping containers restricted to this service exclusively. For export, and for small volume domestic consumers, shipments are made in 12-gauge, 55-gallon steel drums having a single opening closed by inner and outer threaded bungs. The bung opening is in the shell, protected by heavy rolling hoops on either side. Tank cars used in this service are of very heavy steel covered with insulation and a thin outer steel shell. The tanks have no openings at the bottom and the double unloading standpipe and valves are located within a locked steel dome. Both the drums and the tank cars are subjected to frequent rigid inspections.

Importance of Eductor

Basically, the system for the safe handling of tetraethyl lead compounds is simple. The antiknock compound is removed through an opening located at the top of the shipping container and flows through a line under partial vacuum. Consequently, should leaks occur, air will enter the lines rather than fluid leaking out of them. The vacuum is obtained by means of an eductor, which is a liquid jet vacuum pump, operated with gasoline under pressure.

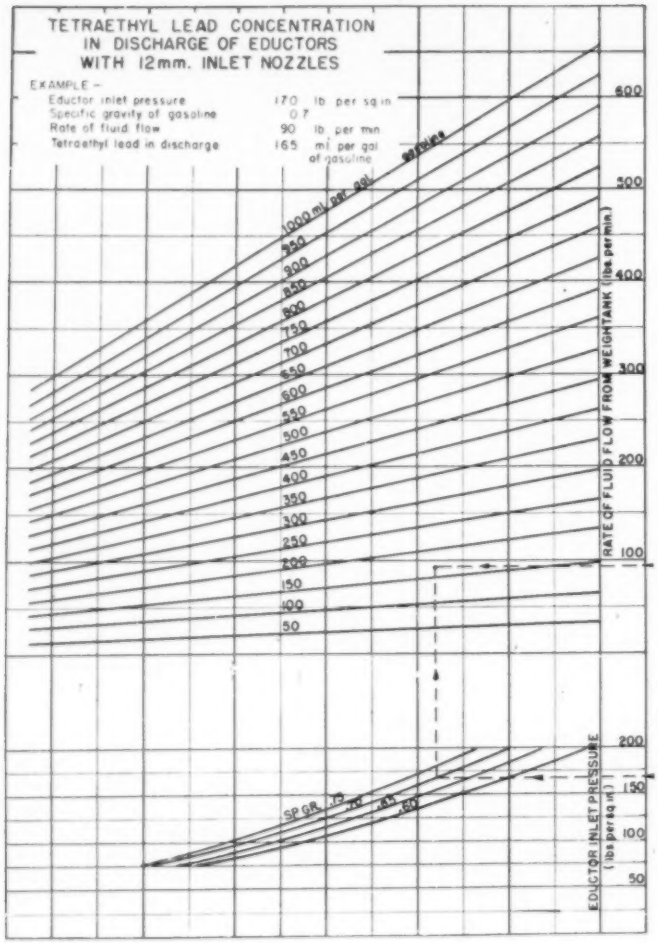

TETRAETHYL LEAD CONCENTRATION
IN DISCHARGE OF EDUCTORS
WITH 12mm. INLET NOZZLES
EXAMPLE –
Eductor inlet pressure 170 lb. per sq in
Specific gravity of gasoline 0.7
Rate of fluid flow 90 lb. per min
Tetraethyl lead in discharge 165 ml. per gal of gasoline
RATE OF FLUID FLOW FROM WEIGH TANK (lbs. per min.)
EDUCTOR INLET PRESSURE (lbs. per sq. in.)
SP GR .70
.72
.74
.76
.80

FIGURE 2

The eductor is, perhaps, the system's most important piece of equipment since all operations depend on its ability to provide reduced pressures. Eductors are fitted with specially designed nozzles to provide good air handling capacity.

The ability of the eductor to produce the required low pressure depends on a proper ratio of inlet pressure to the back pressure against which it must operate. The back pressure can usually be determined at existing plants from the pressure in the lines to which the eductor discharge is connected and it can be calculated for completely new layouts of tanks, lines and pumps. As a minimum, the inlet pressure should be 125 psi. With this pressure, the eductor will operate satisfactorily with back pressures up to 35 psi. For back pressures higher than this, the inlet pressure must be increased. This can be calculated with sufficient accuracy for back pressures up to 100 psi. by using the following empirical formula:

$$P_i = 28 + 3P_b - .0073\,P_i^2$$

where

P_i = Inlet pressure in pounds per square inch.

P_b = Back pressure in pounds per square inch.

The inlet nozzle of eductors used in bulk type installations has a bore of 12 mm. The bore of the inlet nozzle in eductors used at drum plants is 6.75 mm. The volume of gasoline passing through these nozzles may be determined for purposes of eductor pump selection by the following formulas:

For eductors used in bulk type installations:

$$Q = 7.14\sqrt{P_i}$$

where

Q = Volume of gasoline in gallons per minute.

P_i = Inlet pressure in pounds per square inch.

For eductors used in drum-type installations:

$$Q = 2.26\sqrt{P_i}$$

where

Q = Volume of gasoline in gallons per minute.

P_i = Inlet pressure in pounds per square inch.

In developing these equations, the standard equation $V = \sqrt{2gh}$ was used and all the constants and conversion factors were combined. The specific gravity of gasoline was assumed to be 0.70. Tests have shown that the discharge coefficient is 0.90.

Figure 1 shows the proper methods of connecting the eductor pump and eductor manifold with gasoline tank lines. The concentration of tetraethyl lead in eductor discharge lines is very high compared to the permissible concentration in finished gasoline even when there is a slow flow of fluid from weigh tanks. These concentrations can be estimated from the chart shown in Figure 2. Gasoline containing such high concentrations is prevented from passing through pumps to avoid hazardous leakage. Eductor discharge lines are connected to the discharge line of circulating pumps or are connected directly to gasoline tanks where other suitable means for obtaining a homogeneous mixture are used. These lines should be tested periodically and any leaks detected during these tests should be stopped at once for economic reasons as well as a safety measure.

Since the antiknock compound, as delivered, contains a small amount of dye for identification purposes, any leaks that might arise within mixing installations can easily be detected by watching for telltale dye stains. The additional dye that is normally added to finished gasoline is kept separate and apart from the mixing installation, so that stains from this dye cannot be confused with stains caused by the dye originally in the antiknock compound. After the blending operation has been completed, the additional dye may then be added by means of a dye pot, or at larger installations, by means of a separate eductor connected with the circulating pump discharge lines.

The use of tongue and groove joints, characteristic of ammonia type fittings, provides a tight joint. This type of

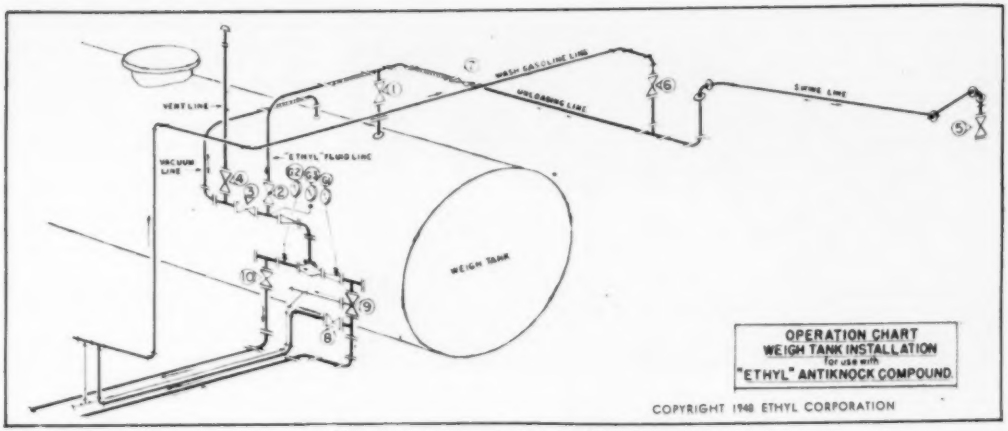


Figure 3. Routine operation chart and directions.

During the operations listed below, the eductor pump is assumed to be running, with valves 9, 10 and all other valves in the circulating loop, between the blending tank and mixing installation, correctly lined up to permit the free flow of product.

ROUTINE OPERATIONS

A. To Empty Contents of Tank Car into Weigh Tank.

Note: All special clothing called for on the Medical Regulations placard must be worn and all required equipment should be available during all of these operations.

In case of trouble with any of the operations, or in case of a spill of Ethyl fluid, follow the instructions on the Medical Regulations placard. Notify the refinery manager and the nearest Ethyl Corporation office at once.

1. To build vacuum on weigh tank: Open gauge valves G1, G2 and G3. Check for a minimum vacuum reading of 15" on G3. Open valve 3 and close valve 4, if open.

2. To test unloading line: Connect unloading line to tank car. Close valve 3. Note vacuum reading on G3. Test line by opening valve 2, 5 and 7. Line is tight if needle of G3 returns to original reading. Close valve 2 and reopen valve 3. Valves 5 and 7 to remain open.

3. To transfer Ethyl fluid from tank car to weigh tank: After a minimum of 10" of vacuum is obtained on weigh tank, open valve 1 and tank car standpipe valve. After three minutes, open air vent in tank car dome. When all the fluid has been transferred, usually indicated by a sudden drop of vacuum reading on G3, close valves 1 and 3. Open valve 4 long enough to relieve and vacuum in tank.

4. To wash tank car (first wash): Screw compound gauge into tank car dome. Open valves 8 and 6 and pump gasoline into tank car until gauge registers 2 pounds pressure. Close valve 8 and open valve 2 to remove wash gasoline. When wash gasoline has been removed, close valve 2. Valve 6 remains open.

Wash car (second wash): Open valve 8 and pump gasoline into tank car until gauge registers 5 pounds pressure. Close valve 8, open valve 2, operate system until gauge on tank car registers 3" vacuum. Close tank car vent valve. Remove compound gauge, close valve 6. Valve 2 remains open.

5. To disconnect unloading swing line from tank car: Break joint, close valve 5 and tank car standpipe valve, then valve 2. Shutdown eductor pump and close all open valves.

NOTE: Valve 4 may be left open until next tank car unloading if glycerine has been added to weigh tank. The open valve 4 serves as a pressure relief valve for the weigh tank. Where Nordstrom plug valve is installed in No. 9 position, with pressure relief connections, the plug should be turned a quarter turn to line up the proper parts for relief of any pressure built up in the manifold.

B. To Make a Mix (Adding Ethyl Fluid to Gasoline).

1. To test eductor and fluid lines: Open gauge valves G1, G2 and G3. Vacuum reading on G3 should be 15" minimum. Open valve 2. Line is tight if needle of vacuum gauge G3 returns to first reading, close valve 2.

2. To remove fluid from tank: Open valve 1. Open valve 2 slowly until flow starts, then open valve 4, if closed. Control rate of flow with valve 2. The slower the rate, the better the mix and the less circulation of product is necessary to obtain a homogenous mixture. When required weight of fluid has been removed, close valve 1. Open valve 2 all the way, close valve 4, if tank does not have glycerine banker.

3. To wash lines: Open valves 6 and 8. After about one minute, close valves 8 and 6 in that order. Close valve after about two minutes. Operate eductor pump long enough to clear discharge line from eductor to blending tank of all gasoline-fluid mixture. Shut down eductor pump and close all valves. (See note under A-5 for proper setting plug valve 9.)

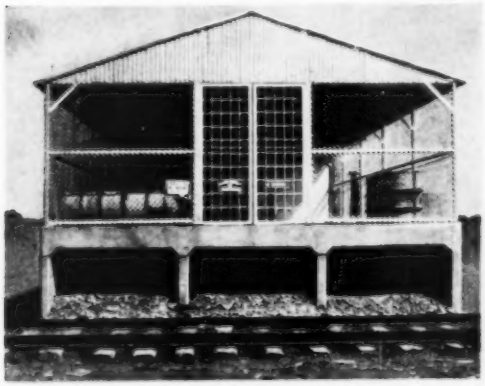
fitting is used in fabricating the eductor and tank manifold.

Two Basic Methods

There are two basic methods for blending finished gasolines.

The first type of mixing installation, which was installed, withdrew "Ethyl" fluid from 55-gallon drums. Similar installations are still in use today. They are suitable for locations away from rail lines or may be used to satisfy limited operational demands. In the operation of these plants, entire drums of compound are used. With the amount of tetraethyl lead fixed, it is first necessary to gauge the gasoline to be mixed in order to obtain the

Figure 4. Left—Typical drum installation. Right—Eductor manifold of typical drum installation.



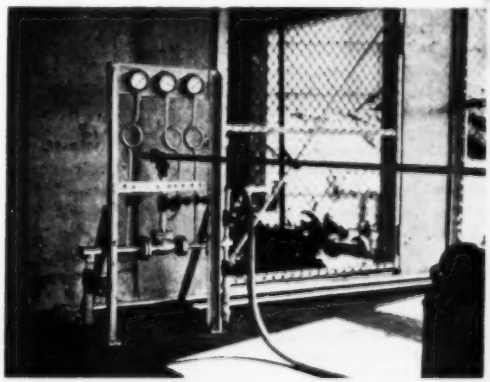


Figure 5. Typical weigh tank installation.

desired concentration.

These installations consist of an eductor manifold placed on a curbed platform provided with suitable drainage. The platform, usually elevated to box car or truck floor heights, is roofed and enclosed on three sides by wire fencing. The remaining side is the wall of a wash and change room. The platform size is based on 100 square feet (10 feet x 10 feet) for operating area, plus 10 square feet for each 55-gallon drum stored. This space is necessary to provide adequate room for the inspection and handling of drums.

As the demand for antiknock compound increased, Ethyl Corporation developed, in 1930, a bulk type of installation. This bulk type plant was an improvement in that it provided more flexibility for the refiner by eliminating the need for gauging gasoline stocks to utilize an exact number of drums. Today, these installations are supplied by specially designed tank cars.

These plants consist of a building which houses a weigh tank mounted on a scale located in a pit. A wash and change room is provided for the operators.

The material is withdrawn from the tank car by utilizing the eductor to create a partial vacuum in the weigh tank. The blending of antiknock compound and gasoline is accomplished by using the eductor to take direct suction from the weigh tank, controlling the flow with special V-port valve in the suction line. The details of these various operations are shown in Figure 3.

The flexibility of weigh tank installations is also made available to large users of compound not adjacent to railroads. These plants make use of a drum storage platform adjacent to the bulk type installation building. Material is transferred from drums to the weigh tank through standpipes connected with the eductor and tank manifold.

Data on the capacity of present bulk type installations whether fluid is supplied by tank car or in drums is offered in Table 1.

TABLE 1

Nominal Size in Gallons	Scale Capacity	Maximum Safe Storage Capacity in Pounds of	
		Motor Compound	Aviation Compound
4,250	30 ton	54,250	59,500
8,500	60 ton	106,000	116,000
15,000	110 ton	183,000	201,000

Increased Storage Capacity

During the war it was necessary to provide for greater storage capacity. This was done by installing tanks, of the same design as weigh tanks, on piers in pits adjacent to the mixing building. These tanks were connected with the weigh tank by means of a modified manifold, which made it possible to transfer fluid between tanks. Since the war, additional tank storage capacity of this type has been constructed.

In the bulk-type installation, a scale fitted with a "weightograph" provides an easy and accurate method of mixing by loss-in-weight. A properly maintained scale will give an accuracy of plus or minus five pounds.

For bulk type installations, a system* has been developed whereby compounds containing tetraethyl lead may be metered into a gasoline flow to provide the desired concentration. A special transmitter responds to the flow of gasoline through a venturi tube and transmits electrical impulses to equipment installed in the mixing plant. By means of these various devices, a balance is maintained between the rate of flow of gasoline and the rate at which fluid is removed from the weigh tank. This system has shown a high degree of efficiency and safety.

Mixing installations supplied with antiknock compounds are regularly inspected by trained personnel to insure that they are maintained in a safe and efficient condition. Operators at these installations are further protected by periodic medical examinations. The sum total of all these efforts has made it possible for the petroleum industry to conduct mixing operations on a safe and economical basis.

* By Proportioneers, Inc., Providence, R. I.

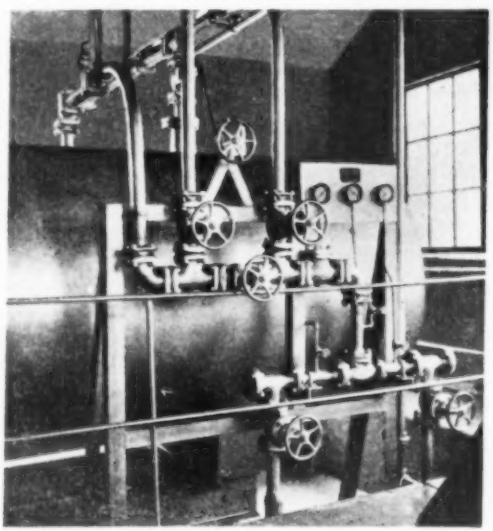


Figure 6. Eductor manifold of typical weigh tank installation.

Transmission Piping for Refinery Steam Systems

Part III

TYLER G. HICKS
Hicks Associates, New York

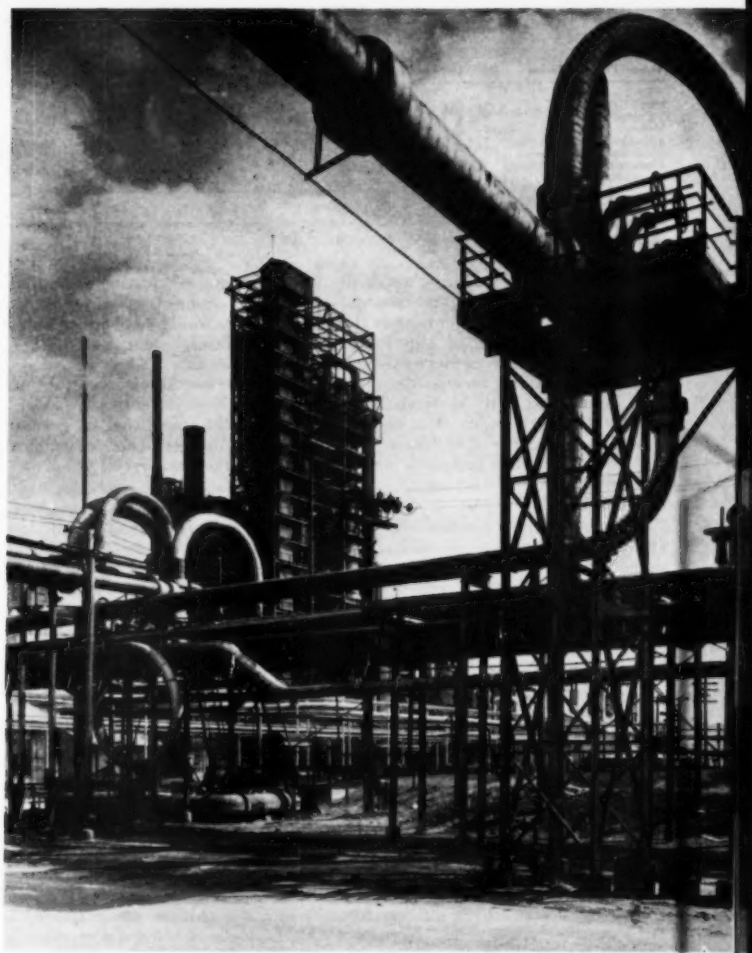


Figure 1: Typical Refinery Steam Transmission Line. (Photo courtesy Crane Company.)

THIS IS the last of a series of articles by Mr. Hicks who set out to discuss the factors in designing steam systems and steam lines serving refineries, a matter that sometimes is given less attention than good engineering would indicate. Few plants, it can be said, claim to have achieved the optimum economic level along these lines. In the first part (Petroleum Refiner, April, 1949) the author discussed general factors involved in the complex problem of designing long steam transmission lines for process plants. In Part II (June, 1949) he treated the problems of thermal expansion and in this he discusses materials and costs.

AFTER a thorough study of pipe sizes and expansion requirements the piping designer has sufficient data to make an economic analysis. In general this analysis need not be accurate down to the last dollar. Usually it is best to aim at obtaining a good approximation of relative costs of various piping methods. Then, later, after selection of the best method, a thorough cost analysis can be made.

Basic material requirements are conveniently summarized as shown in Table 1. In preparing this table the length of pipe needed for expansion loops using welding elbows was approximated. In design work the actual required length would be substituted after loop dimensions were determined. Pipe lengths for other type bends were determined from standard bend tables.

Material costs can be summarized as in Table 2. The costs used in preparing this table were the most accurate available at the time of writing. However, the actual numerical values should not be used for similar design work because price changes may cause them to be far off.

The important findings in such a tabulation are differences in total cost. These differences will remain substantially constant even though prices change. Hence, if a difference of $8000 exists between two types of construction, it may be assumed that this value will be about the same after a price rise of say 25 percent.

Study of Table 2 shows that, in general, lines using double offset U bends

TABLE 1

Summary of Material Requirements for Various Lines

Nominal Pipe Size, Inches	16-Inch Nominal Pressure Loss				10-Inch Maximum Pressure Loss			
Means Used to Absorb Expansion	Plain U Bends	Double Offset U Bends	Slip Joints	Welding Elbows[1]	Plain U Bends	Double Offset U Bends	Slip Joints	Welding Elbows[2]
Approximate Footage of Pipe and Insulation Required	2,050	1,960	1,700	1,955	2,120	1,985	1,700	2,040
Approximate Number of Supports Required	123	118	102	117	127	119	102	123
Number of Anchors Required	9	4	3	4	9	6	4	4

[1] Assumed to be 15 percent of straight pipe length.
[2] Assumed to be 20 percent of straight pipe length.

or welding elbows have lowest material first costs. However, high first costs do not rule out slip joints or plain U bends. Frequently use of slip joints will eliminate offsets to clear existing buildings or piping because the pipe path is straight. Plain U bends have smaller over-all heights than double offset U bends. For this reason the plain bend is often preferred where pipe is run through congested areas of refineries.

Often, past piping practice will govern line selection. For instance, in a refinery which has made wide use of slip joints, slightly higher cost of such a line might be overlooked. Preference might also be shown for plain U bends, double offset U bends, or welding elbow bends.

The values given in Table 2 do not include installation and annual operating costs. These have been omitted because accurate estimates are difficult to make unless actual conditions are known. Thus, installation costs may vary considerably according to who does the work. Annual costs are a function of the allowable depreciation and average cost of money. For a given proposed transmission line of this type, annual costs will usually be less for the smaller line. The economic analysis, as made by the piping designer, should include all costs relevant to installation and operation of the line. Allowable cost of money and depreciation values are best obtained from the accounting department of the firm for whom the line is designed.

Perhaps the most important result of the cost tabulation is the difference between the 16-inch and 10-inch line costs. Table 2 indicates that from the standpoint of first cost, the smaller line is better. This smaller first cost is not, however, obtained without losing some big line advantages.

It will be recalled that in Part I of this series (PR, April, 1949) the final steam conditions were computed. Steam leaving the 16-inch nominal pressure loss line was shown to be saturated at 150 psia. Desired leaving conditions were obtained without use of special control.

In the 10-inch maximum pressure loss line, desired leaving conditions were not obtained. Slightly superheated steam would be obtained unless special controls were used. Where exact temperature values are needed for the process, special controls are necessary. Neglecting this disadvantage, it will be found that, in general, the small line is more economical than the large one.

Besides lower first cost, the small line loses less heat to the atmosphere, has smaller anchor forces, and does not cause steam condensation during average flows. Lower heat losses and condensation reduce operating costs. Therefore, if special temperature controls are not objectionable, the 10-inch maximum pressure loss line will be a better installation.

Such a conclusion neglects the possibility of future refinery expansion. Where expansion is anticipated it will generally be found that installation of a small line now and another one later to care for increased steam requirements is uneconomical. Instead, installation of a large nominal pressure loss line now which can later be operated as a maximum pressure loss line will be found more economical. Besides the obvious advantages of a single line in crowded spaces, there is a reduction in installation and maintenance costs.

As shown in Part I of this discussion, condensate removal piping and equipment is necessary for both lines. While the equipment necessary for the 10-inch line is smaller and less extensive than for the 16-inch line, careful thought must be given to its design. Water hammer is seldom considered a nuisance from the noise standpoint in refineries. However, the additional maintenance which usually results from water hammer requires that sufficient trapping and drainage capacity be supplied.

Thus condensate removal becomes an economic problem. An inadequate removal system, while low in first cost, will increase maintenance costs. An adequate removal system, having a slightly higher first cost, will considerably reduce maintenance costs.

In general, condensate drips should be provided for every 100 feet of pipe regardless of line size. The steam transmission line is pitched towards the trap if possible. Where condensate must flow against steam, main line pitch in direction of condensate flow is a necessity. Every vertical rise of the main line must also be dripped. Each drip line should be connected to a trap and then run to the point of disposal or return.

Condensate disposal or return is also an economic problem. In refineries where suitable raw water is plentiful, and hence inexpensive, condensate is often discharged to the plant sewer. This is usually the simplest and least expensive means of disposal. Where water is scarce or requires extensive treatment before use, return of condensate to the boiler plant is usually justifiable. Condensate return requires collection at some common point and, usually, installation of a pump for handling returns.

Conclusion

Neglect of any of the factors discussed in the three parts of this article may result in poorly designed refinery steam transmission lines. On the other hand, use of the data and curves presented will usually reduce design time considerably. Extensive refinery line design experience has shown that economical and efficient steam lines are more readily obtained when systematic analyses and computations are made.

TABLE 2

Approximate Material Costs for Various Lines

Nominal Pipe Size, Inches	16-Inch Nominal Pressure Loss				10-Inch Maximum Pressure Loss			
Means Used to Absorb Expansion	Plain U Bends	Double Offset U Bends	Slip Joints	Welding Elbows	Plain U Bends	Double Offset U Bends	Slip Joints	Welding Elbows
Cost of Pipe and Bends or Joints	$38,500	$32,500	$41,500	$32,500	$18,000	$16,000	$22,750	$16,000
Cost of Insulation	5,650	5,400	4,675	5,375	3,700	3,500	3,000	3,600
Cost of Supports	2,400	2,300	2,000	2,300	1,800	1,700	1,500	1,800
Cost of Anchors	1,800	800	600	800	1,000	600	400	400
Condensate Removal Equipment	3,000	3,000	3,000	3,000	2,000	2,000	2,000	2,000
Total Material Costs	$51,350	$44,000	$51,775	$43,975	$26,500	$23,800	$29,650	$23,800

THERMOCHEMISTRY for the Petrochemical Industry

Part V—Aromatic Hydrocarbons

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DR. KOBE, professor of chemical engineering at the University of Texas, and Mr. Long, Celanese Corporation fellow in chemical engineering there, have combined their efforts in this series to put into useful form the basic thermodynamic data needed by technical men who have to make thermodynamic calculations. Their aim is to collect heat capacity and enthalpy data on important gases and vapors, to evaluate them and present the most reliable in useable form.

IN PREVIOUS papers[11, 12, 13] of this series the thermodynamic data for the lower paraffinic, the lower monoolefinic and four of the cycloparaffinic hydrocarbons have been presented. The first paper[10] concerned itself with the general aims, methods and utility of the series. This article presents the thermodynamic data for the following aromatic hydrocarbons: benzene, toluene, ethylbenzene, styrene, and cumene (isopropylbenzene).

As would be expected, benzene has been the subject of considerable work, both calorimetric and spectroscopic. Probably the best spectroscopic calculations for benzene are those of Taylor, Wagman, Williams, Pitzer and Rossini.[22] The best thermodynamic data for toluene, ethylbenzene and cumene are included in the same paper. These data were used in the API Research Project 44,[18] which is the primary data source for this paper. In like manner the spectroscopic results of Beckett and Pitzer[1] for styrene were used here and in the API 44 report.

The thermodynamic functions of cumene (isopropylbenzene) are not the results of direct calculations. The method is the same as that used by Kilpatrick, Werner, Beckett, Pitzer and Rossini[9] for the calculations on methylcyclopentane. The thermodynamic functions of isopropylbenzene were calculated by the following formula:

$$[\text{Isopropylbenzene}] = [\text{Ethylbenzene}] + [\text{Isobutane}] - [\text{Propane}] + (R \ln 3/2). \quad (1)$$

The symmetry number correction ($R \ln 3/2$) was used for the free energy function and for the entropy but not for the other functions (including heat capacity). As with methylcyclopentane, there apparently have been no calorimetric determinations of the gaseous heat capacity of cumene. However, one value (at 28.87° C.) was obtained for liquid cumene by Kolosovski and Udovenko[14] in 1934.

The various sources of heat capacity data for this series of compounds are listed in Table 1. The standard heats of formation and combustion and the standard free energies of formation from the API 44 report appear as Table 2.

Tables 3, 4, 5 and 6 are recommended ideal heat capacities from 0 to 1200° C. on the Centrigrade, Kelvin, Fahrenheit and Rankine temperature scales. These data, on the Centrigrade and Fahrenheit scales, are plotted as Figure 1.

The molal enthalpies relative to the ice-point are presented as Tables 7, 8, 9 and 10. These data were calculated

TABLE 1
Reported Heat Capacities of Aromatic Hydrocarbons

Compound	Temperature Range	Method	Workers	Reference
Benzene	410° K.	Calorimetric	Bennewits and Rossner	2
	440° K.	Calorimetric	Regnault	17
	380° K.	Calorimetric	Wiedemann	23
	370° K.	C_p ratio	Dejardin	4
	97- 134° C.	Supersonic	Jatkar	8
	90° C.	Velocity of sound	Dixon and Greenwood	5
	450- 480° K.	Calorimetric	Eucken and Sarstedt	6
	393- 463° K.	Calorimetric	Pitzer and Scott	16
	388- 481° K.	Calorimetric	Gwinn, W. D.	16
	370- 410° K.	Calorimetric	Montgomery and deVries	15
	341- 471° K.	Calorimetric	Scott, Waddington, Smith and Huffman	19
	298-1500° K.	Spectroscopic	Pitzer and Scott	16
	20- 350° C.	Spectroscopic	Fugassi and Rudy	7
	250-1500° K.	Spectroscopic	Stull and Mayfield	21
	298-1500° K.	Spectroscopic	Taylor, Wagman, Williams, Pitzer and Rossini	22
	273-1500° K.	Compilation	API 44	18
Toluene	410° K.	Calorimetric	Bennewits and Rossner	2
	390- 410° K.	Calorimetric	Montgomery and deVries	15
	393- 463° K.	Calorimetric	Pitzer and Scott	16
	250-1500° K.	Spectroscopic	Stull and Mayfield	21
	298-1500° K.	Spectroscopic	Pitzer and Scott	16
	298-1500° K.	Spectroscopic	Taylor, Wagman, Williams, Pitzer and Rossini	22
	273-1500° K.	Compilation	API 44	18
Ethylbenzene	100° C.	Calorimetric	Scott and Mellors	20
	250-1500° K.	Spectroscopic	Stull and Mayfield	21
	300-1500° K.	Spectroscopic	Brickwedded, Moskow and Scott	3
	298-1500° K.	Spectroscopic	Taylor, Wagman, Williams, Pitzer and Rossini	22
	273-1500° K.	Compilation	API 44	18
Styrene	100° C.	Calorimetric	Scott and Mellors	20
	250-1500° K.	Spectroscopic	Stull and Mayfield	21
	298-1500° K.	Spectroscopic	Beckett and Pitzer	1
	273-1500° K.	Compilation	API 44	18
Cumene (isopropylbenzene)	28.87° C.	Calorimetric (Liquid)	Kolosovski and Udovenko	14
	298-1500° K.	"Increments"	Taylor, Wagman, Williams, Pitzer and Rossini	22
	273-1500° K.	Compilation	API 44	18

TABLE 2
Free Energies of Formation, Heats of Formation and Heats of Combustion of Aromatic Hydrocarbons, at 25° C.[1]

	Molecular Weight	$\Delta G°_f$ cal./g-mole	$\Delta H°_f$ cal./g-mole	$-\Delta H°_c$ cal./g-mole: H_2O (liq.), CO_2 (gas)	$-\Delta H°_c$ cal./g-mole: H_2O (gas), CO_2 (gas)
Benzene	78.108	30,989	19,820	789,080	757,520
Toluene	92.134	29,228	11,950	943,580	901,500
Ethylbenzene	106.160	31,208	7,120	1,101,130	1,048,530
Styrene	104.144	51,100	35,220	1,069,900	1,018,830
Cumene	120.186	32,738	940	1,257,310	1,194,150

[1] $-\Delta H°_c$ represents the heat evolved at 25° C. and constant pressure in the combustion of the gaseous hydrocarbon in gaseous oxygen to form the products indicated with all the reactants and products in their appropriate standard reference states.

$\Delta H°_f$ and $\Delta G°_f$ represent the changes in the heat content (enthalpy) and free energy respectively, for the formation of the gaseous hydrocarbons from the elements, with all the reactants and products in their appropriate standard reference states.

TABLE 3

Heat Capacities of Aromatic Hydrocarbons
cal./g-mole • °C.

°C.	Benzene	Toluene	Ethylbenzene	Styrene	Cumene
0	17.70	22.69	28.19	26.72	33.28
18	18.97	24.16	29.95	28.47	35.36
25	19.52	24.80	30.69	29.18	36.26
100	24.93	31.11	38.22	36.04	45.1
200	31.28	38.70	47.19	44.03	55.4
300	36.52	45.07	54.67	50.60	64.2
400	40.75	50.31	60.82	55.95	71.3
500	44.23	54.68	65.93	60.35	77.2
600	47.13	58.34	70.22	64.04	82.1
700	49.58	61.44	73.88	67.16	86.3
800	51.65	64.09	77.01	69.83	89.9
900	53.43	66.35	79.69	72.11	93.0
1000	54.94	68.30	82.01	74.07	95.8
1100	56.25	69.98	84.00	75.74	98.1
1200	57.39	71.42	85.73	77.21	100.1

TABLE 4

Heat Capacities of Aromatic Hydrocarbons
cal./g-mole • °K.

°K.	Benzene	Toluene	Ethylbenzene	Styrene	Cumene
273	17.70	22.69	28.19	26.72	33.28
291	18.97	24.16	29.95	28.47	35.36
298	19.52	24.80	30.69	29.18	36.26
300	19.65	24.95	30.86	29.35	36.47
400	26.75	33.25	40.76	38.32	48.0
500	32.80	40.54	49.35	45.94	57.9
600	37.74	46.58	56.44	52.14	66.2
700	41.75	51.57	62.28	57.21	72.9
800	45.06	55.72	67.15	61.40	78.6
900	47.83	59.22	71.27	64.93	83.3
1000	50.16	62.19	74.77	67.92	87.3
1100	52.16	64.73	77.77	70.48	90.8
1200	53.86	66.90	80.35	72.66	93.8
1300	55.32	68.77	82.57	74.54	96.4
1400	56.58	70.38	84.49	76.16	98.6
1500	57.67	71.78	86.16	77.57	100.6

TABLE 5

Heat Capacities of Aromatic Hydrocarbons
Btu./lb.-mole • °F.

°F.	Benzene	Toluene	Ethylbenzene	Styrene	Cumene
32	17.70	22.69	28.19	26.72	33.28
60	18.80	23.95	29.67	28.23	35.06
77	19.52	24.80	30.69	29.18	36.26
100	20.46	25.88	32.00	30.38	37.77
200	24.46	30.55	37.56	35.44	44.2
300	28.15	34.93	42.74	40.10	50.2
400	31.52	38.98	47.52	44.32	55.8
500	34.53	42.64	51.83	48.10	60.8
600	37.21	45.92	55.67	51.47	65.3
700	39.59	48.87	59.12	54.48	69.2
800	41.72	51.52	62.23	57.16	72.8
900	43.63	53.93	65.03	59.59	76.1
1000	45.36	56.10	67.58	61.78	79.1
1100	46.93	58.08	69.92	63.77	81.7
1200	48.36	59.88	72.04	65.59	84.3
1300	49.65	61.53	73.98	67.25	86.4
1400	50.84	63.04	75.77	68.77	88.5
1500	51.92	64.42	77.40	70.16	90.4
1600	52.91	65.69	78.91	71.44	92.2
1700	53.82	66.85	80.29	72.61	93.7
1800	54.66	67.93	81.56	73.69	95.2
1900	55.43	68.92	82.74	74.68	96.6
2000	56.14	69.82	83.82	75.59	97.8
2100	56.79	70.66	84.82	76.44	99.0
2200	57.39	71.44	85.75	77.22	100.1

TABLE 6

Heat Capacities of Aromatic Hydrocarbons
Btu./lb.-mole • °R.

°R.	Benzene	Toluene	Ethylbenzene	Styrene	Cumene
492	17.70	22.69	28.19	26.72	33.28
500	18.01	23.05	28.61	27.15	33.79
520	18.80	23.95	29.67	28.23	35.06
537	19.52	24.80	30.69	29.18	36.26
600	22.06	27.75	34.22	32.40	40.3
700	25.99	32.35	39.69	37.36	46.7
800	29.50	36.55	44.65	41.79	52.4
900	32.80	40.54	49.35	45.94	57.9
1000	35.60	43.95	53.37	49.45	62.6
1100	38.20	47.15	57.11	52.73	67.0
1200	40.44	49.93	60.36	55.55	70.6
1300	42.48	52.48	63.35	58.13	74.1
1400	44.20	54.65	65.88	60.31	77.1
1500	45.99	56.89	68.52	62.58	80.1
1600	47.47	58.76	70.73	64.47	82.7
1700	48.87	60.54	72.82	66.25	85.1
1800	50.16	62.19	74.77	67.92	87.3
1900	51.26	63.59	76.42	69.33	89.3
2000	52.33	64.97	78.06	70.72	91.2
2100	53.27	66.15	79.46	71.91	92.8
2200	54.16	67.28	80.80	73.04	94.3
2300	54.92	68.27	81.96	74.03	95.7
2400	55.71	69.28	83.17	75.04	97.1
2500	56.43	70.19	84.27	75.97	98.3
2600	57.03	70.97	85.19	76.75	99.4

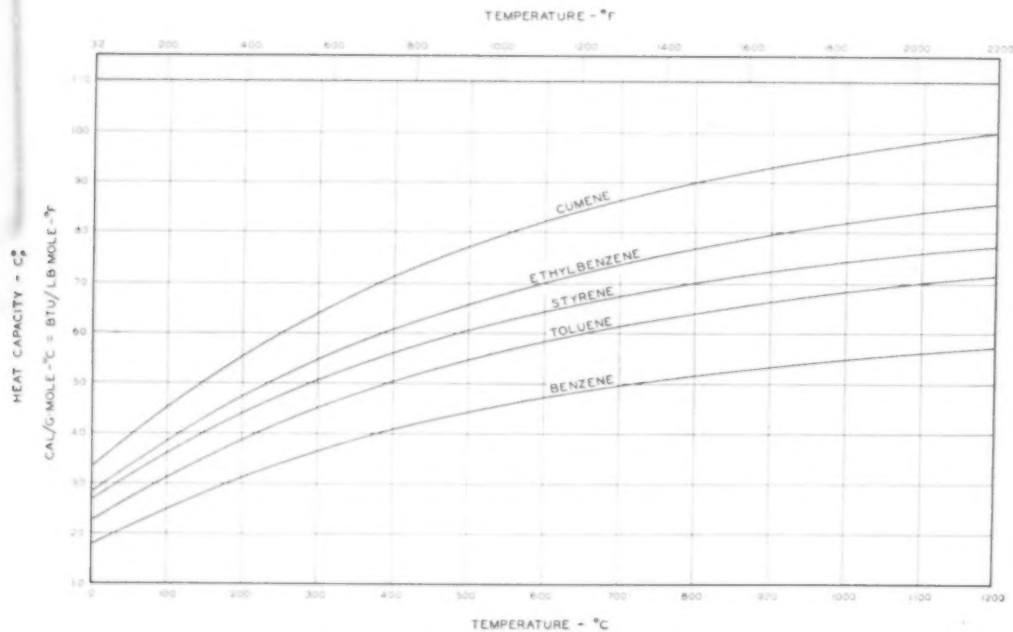

Figure 1. Heat Capacities of Some Aromatic Hydrocarbons

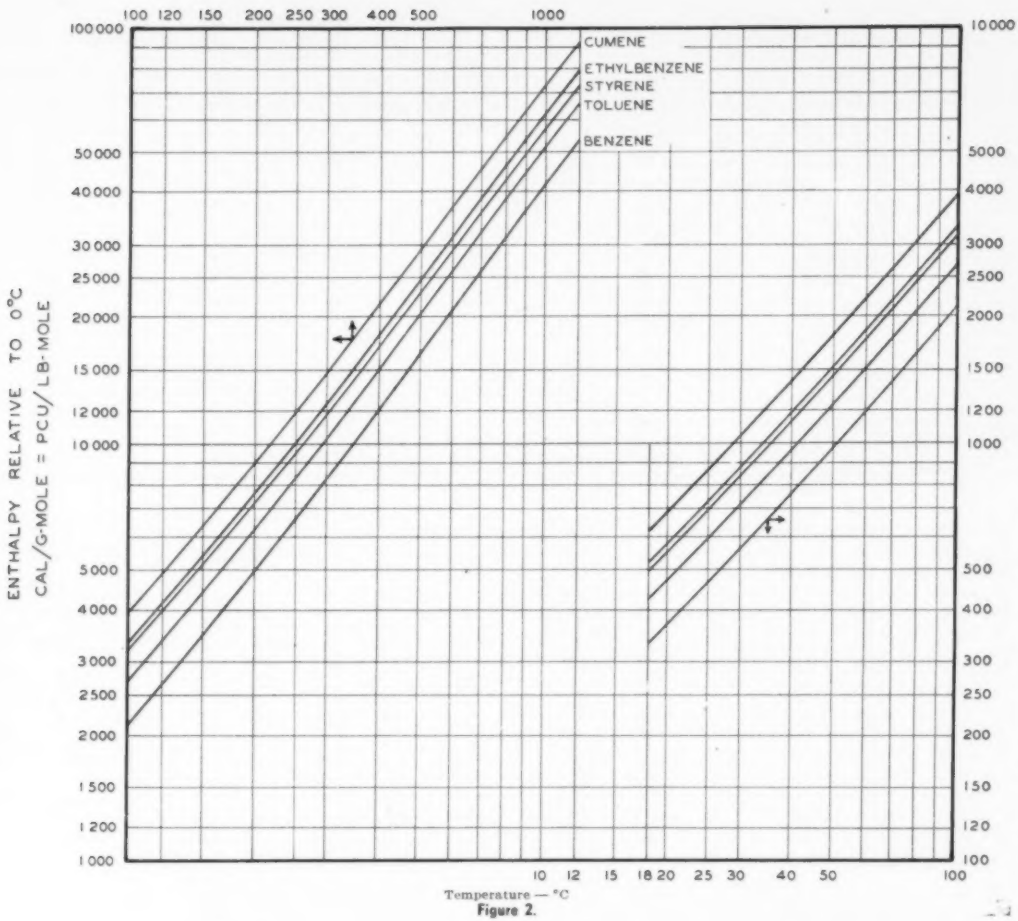

Figure 2.

TABLE 7
Enthalpies of Aromatic Hydrocarbons
cal./g-mole

°C.	Benzene	Toluene	Ethylbenzene	Styrene	Cumene
0	0.0	0.0	0.0	0.0	0.0
18	330.	421.9	522.8	497.1	616.5
25	464.9	593.3	735.0	698.9	867.2
100	2123.	2692.	3322.	3147.	3922.
200	4964.	6188.	7600.	7160.	8949.
300	8360.	10380.	12700.	11900.	14940.
400	12190.	15160.	18480.	17230.	21710.
500	16300.	20410.	24820.	23050.	29130.
600	21090.	26060.	31630.	29270.	37090.
700	25900.	32050.	38840.	35830.	45520.
800	30970.	38380.	46380.	42680.	54320.
900	36230.	44900.	54210.	49770.	63470.
1000	41650.	51640.	62300.	57080.	72910.
1100	47210.	58550.	70590.	64570.	82590.
1200	52890.	65600.	79080.	72210.	92490.

TABLE 8
Enthalpies of Aromatic Hydrocarbons
cal./g-mole

°K.	Benzene	Toluene	Ethylbenzene	Styrene	Cumene
273	0.0	0.0	0.0	0.0	0.0
291	330.1	421.9	522.8	497.1	616.5
298	464.9	593.3	735.0	698.9	867.2
300	504.1	643.1	796.6	757.5	939.9
400	2839.	3549.	4474.	4139.	5159.
500	5825.	7244.	8886.	8358.	10465.
600	9357.	11604.	14183.	13267.	16680.
700	13346.	16515.	20120.	18740.	23630.
800	17690.	21880.	26590.	24670.	31200.
900	22340.	27630.	33520.	30990.	39290.
1000	27240.	33700.	40820.	37630.	47830.
1100	32360.	40100.	48440.	44550.	56730.
1200	37670.	46680.	56350.	51700.	65960.
1300	43130.	53460.	64430.	59170.	75470.
1400	48720.	60420.	72840.	66590.	85210.
1500	54440.	67520.	81370.	74270.	95170.

by careful integration of the temperature-heat capacity relations of each compound. Figure 2, a double logarithmic plot, is a graphical presentation of the enthalpy data.

From the enthalpy data the mean heat capacities (also relative to the ice-point) were calculated and are presented in Tables 11 and 12. The mean heat capacity values of Tables 11 and 12 are therefore equivalent to the enthalpy values of Tables 7 and 9, respectively.

The heat capacity equations developed for these compounds are quite accurate. The poorest equation of the five is that for styrene in which the maximum error is all of 0.37 percent and the average error is 0.23 percent. The equation for toluene is the best, showing a maximum error of 0.29 percent, and an average error of 0.18 percent. (See tables, next page.)

TABLE 9

Enthalpies of Aromatic Hydrocarbons
Btu./lb.-mole

°F.	Benzene	Toluene	Ethylbenzene	Styrene	Cumene
32	0.0	0.0	0.0	0.0	0.0
60	311.1	653.2	810.2	769.5	954.9
77	536.8	1068.	1323.	1258.	1561.
100	1297.	1651.	2044.	1943.	2413.
200	3535.	4475.	5525.	5237.	6523.
300	6208.	7752.	9543.	9017.	11250.
400	9199.	11450.	14060.	13240.	16550.
500	12445.	15530.	19030.	17860.	22390.
600	16040.	19960.	24410.	22850.	28700.
700	19940.	24710.	30150.	28140.	35430.
800	24020.	29730.	36220.	33730.	42530.
900	28300.	35000.	42590.	39570.	49980.
1000	32750.	40500.	49220.	45640.	57740.
1100	37370.	46210.	56090.	51920.	65780.
1200	42140.	52110.	63190.	58390.	74080.
1300	47040.	58180.	70500.	65030.	82620.
1400	52070.	64510.	77980.	71830.	91360.
1500	57210.	70890.	85640.	78780.	100310.
1600	62450.	77390.	93460.	85860.	109430.
1700	67800.	84020.	101420.	93060.	118730.
1800	73210.	90760.	109520.	100380.	128180.
1900	78730.	97610.	117730.	107800.	137770.
2000	84320.	104540.	126060.	115310.	147490.
2100	89970.	111570.	134490.	122910.	157330.
2200	95690.	118670.	143020.	130600.	167290.

TABLE 10

Enthalpies of Aromatic Hydrocarbons
Btu./lb.-mole

°R.	Benzene	Toluene	Ethylbenzene	Styrene	Cumene
492	0.0	0.0	0.0	0.0	0.0
500	142.9	183.0	227.2	215.5	266.3
520	511.1	653.2	810.2	769.5	954.9
537	836.8	1068.	1323.	1258.	1561.
600	2147.	2724.	3369.	3200.	3974.
700	4249.	5733.	7070.	6693.	8351.
800	7035.	9182.	11290.	10656.	13310.
900	10155.	13040.	16000.	15050.	18840.
1000	13630.	17270.	21140.	19820.	24870.
1100	17320.	21820.	26720.	24930.	31360.
1200	21250.	26680.	32540.	30340.	38240.
1300	25400.	31810.	38730.	36030.	45480.
1400	29750.	37170.	45210.	41970.	53050.
1500	34380.	42760.	51970.	48120.	60930.
1600	39260.	48550.	58910.	54480.	69070.
1700	44080.	54520.	66090.	61020.	77480.
1800	49040.	60660.	73470.	67730.	86100.
1900	54110.	67050.	81030.	74590.	94920.
2000	59300.	73470.	88750.	81590.	103940.
2100	64580.	80030.	96630.	88730.	113140.
2200	69960.	86710.	104640.	95980.	122500.
2300	75420.	93490.	112790.	103330.	132000.
2400	80960.	100370.	121050.	110790.	141650.
2500	86750.	107340.	129420.	118340.	151420.
2600	92250.	114400.	137890.	125980.	161310.

TABLE 11

Mean Heat Capacities of Aromatic Hydrocarbons
cal./g-mole • °C.

°C.	Benzene	Toluene	Ethylbenzene	Styrene	Cumene
0	17.70	22.69	28.19	26.72	33.28
18	18.34	23.44	29.04	27.62	34.25
25	18.60	23.73	29.40	27.96	34.69
100	21.23	26.92	33.22	31.47	39.22
200	24.82	30.94	38.00	35.80	44.74
300	27.57	34.61	42.34	39.66	49.79
400	30.48	37.89	46.21	43.07	54.28
500	32.99	40.81	49.65	46.10	58.26
600	35.14	43.44	52.72	48.78	61.82
700	37.00	45.79	55.48	51.18	65.02
800	38.71	47.98	57.98	53.35	67.90
900	40.25	49.89	60.24	55.30	70.52
1000	41.65	51.64	62.30	57.08	72.91
1100	42.92	53.22	64.18	58.70	75.09
1200	44.08	54.68	65.90	60.18	77.08

TABLE 12

Mean Heat Capacities of Aromatic Hydrocarbons
Btu./lb.-mole • °F.

°F.	Benzene	Toluene	Ethylbenzene	Styrene	Cumene
32	17.70	22.69	28.19	26.72	33.28
60	18.25	23.33	28.94	27.48	34.10
77	18.60	23.73	29.40	27.96	34.60
100	19.07	24.28	30.06	28.57	35.49
200	21.04	26.64	32.83	31.17	38.83
300	23.17	28.92	35.61	33.65	41.97
400	24.80	31.11	38.20	35.98	44.98
500	26.59	33.19	40.66	38.17	47.84
600	28.31	35.15	42.97	40.22	50.53
700	29.85	36.98	45.13	42.13	53.04
800	31.24	38.71	47.16	43.91	55.38
900	32.61	40.32	49.06	45.58	57.58
1000	33.84	42.84	50.84	47.15	59.65
1100	34.99	43.27	52.52	48.61	61.59
1200	36.08	44.62	54.10	49.99	63.43
1300	37.10	45.89	55.60	51.28	65.16
1400	38.06	47.16	57.01	52.51	66.79
1500	38.97	48.29	58.34	53.66	68.33
1600	39.83	49.36	59.61	54.76	69.79
1700	40.65	50.37	60.80	55.79	71.18
1800	41.41	51.34	61.94	56.78	72.50
1900	42.13	52.25	63.03	57.71	73.75
2000	42.85	53.12	64.05	58.59	74.95
2100	43.51	53.95	65.04	59.44	76.08
2200	44.14	54.74	65.97	60.24	77.16

TABLE 13

Heat Capacity Equations[1] of Aromatic Hydrocarbons
cal./lb.-mole • °C. or °K.
Btu./lb.-mole • °F. or °R.

$$C_p^\circ = a + b(t) + c(t^2) + d(t^3)$$

	t	a	b × 10²[1]	c × 10⁵	d × 10⁸	ERROR Max. Percent	ERROR Avg. Percent
Benzene:	°C.	17.700	7.875	−6.022	1.854	0.34	0.20
	°K.	−8.850	11.578	−7.540	1.854		
	°F.	16.332	4.493	−1.888	0.3179		
	°R.	−8.650	6.432	−2.327	0.3179		
Toluene:	°C.	22.509	9.292	−6.658	1.920	0.29	0.18
	°K.	−8.213	13.357	−8.230	1.920		
	°F.	20.569	5.293	−2.086	0.3292		
	°R.	−8.213	7.421	−2.540	0.3292		
Ethyl-benzene:	°C.	28.120	11.010	−8.041	2.395	0.34	0.19
	°K.	−8.398	15.935	−10.003	2.395		
	°F.	26.194	6.274	−2.520	0.4107		
	°R.	−8.398	8.853	−3.087	0.4107		
Styrene:	°C.	26.847	9.851	−7.346	2.203	0.37	0.23
	°K.	−5.968	14.354	−9.150	2.203		
	°F.	25.104	5.616	−2.303	0.3777		
	°R.	−5.968	7.974	−2.824	0.3777		
Cumene:	°C.	33.280	12.850	−9.510	2.880	0.36	0.17
	°K.	−9.452	18.686	−11.869	2.880		
	°F.	31.031	7.324	−2.982	0.4938		
	°R.	−9.452	10.381	−3.663	0.4938		

[1] Temperature Ranges:
0—1200 °C.
273—1500 °K.
32—2200 °F.
492—2600 °R.

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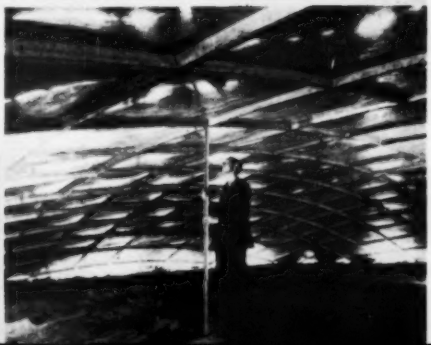
* * *

Top: Rib structure at the experimental roof in position at ground level. Bottom: After tests for deflection reading were obtained by covering the experimental roof with bricks, the dome was stripped to obtain distortion readings. After receiving a super load of 27 pounds to the square foot deflection readings were reported so small as to be masked by temperature effects.

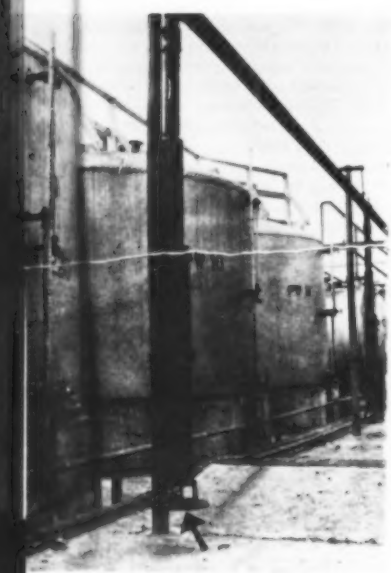
Great Strength Claimed for Aluminum Roof

A new patent, "self-supporting" aluminum roof now being manufactured by the British firm of Aluminum Construction Company, Norfolk House, Strand, London, is claimed to have the same strength as a similar steel structure. It is intended primarily as a roof for oil or chemical storage tanks. An experimental model, 83 feet in diameter with a 9-foot rise was built at ground level and tested to a super load of 27 lbs. to the square foot. This was done by covering the dome with bricks and taking vertical deflection readings at nine points of the framework. "In spite of the fact that mathematicians have never been able to discover the point where a uniform spherical shell becomes unstable under uniform pressure, pre-construction theoretical computations of mathematician G. P. Manning were vindicated in the practical test," company officials said. Designed by W. Hamilton, the new roof is made of extruded aluminum tubes, 2½ x 2½ inches outside, by 2⅛ x 2⅛ inches inside, curved to a radius of 100 feet and forming transverse ribs at intervals of 5 feet. Aluminum sheet is riveted to the structure, and the joints may be welded if necessary to render the whole airtight. Six men can erect the framework and weld all shoes to the outer support ring in one day. Since under symmetrical loading they support themselves by tensile and compressive stresses, aluminum roofs of this type are said to be capable of a span between 500 and 600 feet.

Layout below shows—Top, left: Detail of the ball-and-socket type shoes for rib ends. Bottom, left: Designer W. Hamilton is shown on the left and mathematician Manning (center), authority on concrete structures, demonstrating a section of the roof tubing showing how the ribs are tenon-jointed at the point of crossing. On the right is H. M. Garland Wells, co-director of the Aluminum Construction Company, Ltd. Top center: A typical cross-joint where the ribs meet the outer support ring. The ball-and-socket type shoes pictured here are of the type used for the first experimental structure when they were welded into position. Bottom right: A deflection reading is taken by vernier beneath the experimental roof. Top right: Riveting the 16-gauge aluminum sheeting to the top of the ribs. To insure accurate drilling into the rib members a template is used. The roof may be insulated by packing insulating material into the rib-bays, with sheeting above and below. Test loading of 120 lbs. per square foot on a 5 feet x 5 feet aluminum sheet of 16-gauge shows ample strength reserve, officials said.



New Type Foam System Used



A NEW method of fire protection for plants using such solvents as benzine and gasoline has been installed at the Brunswick, Ga., plant of Hercules Powder Company. For highly flammable products, the new system is a fixed foam installation, which according to tests, extinguishes solvent fires in less than three minutes with little possibility of reignition. Officials believe that the new foam installations mark a pioneering step in the design of fire protection for solvent process buildings.

The plant uses benzine in an extractor house and refinery and gasoline and furfural in another process plant.

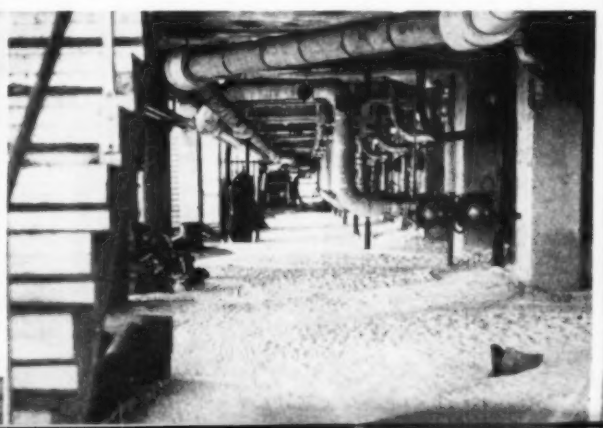
National Foam System engineers from Philadelphia collaborated with Hercules technicians under the direction of C. L. Jones, safety engineer of Hercules. The system devised uses typical floor or marine nozzles **(indicated by arrow in photo at left)** and foam liquid, which covers floors with a foam blanket at least six inches deep within three minutes or less **(See bottom photos taken at a three-minute interval.)** More than 35,000 square feet, in the extractor house is protected at a rate of foam application in excess of the minimum requirements set by the Underwriters' Laboratories for tankage protection.

Foam liquid comprises about 6 percent of the water-foam solution of the foam blanket. Sixty-six hundred gallons per minute of waterfoam solution can be delivered to the three foam-protected buildings in the plant, which produces about 66,000 gallons of foam per minute.

One man by operating a few switches **(top photo)** can arrange for the discharge of foam from all outlets of the fixed foam systems within about one minute after a fire starts. Installation was made on the basis that if fires should occur, those of greatest severity would be at the floor or ground levels from a spill of benzine, gasoline, or other solvent. Therefore, foam applicators are placed about 9 to 12 inches from the floor. Foam is stored in a 10,000 gallon steel tank above the ground level.

Curbs, six inches high, have been installed around the buildings' perimeters on every floor to help build up the required depth of foam. If a flammable liquid spill occurs, it is retained within the curbs and the foam blanket applied effectively smothers the fire.

In tests involving a surface area of 800 square feet covered by 700 gallons of benzine, the fire was extinguished in less than three minutes. The blanket of foam was so effective, that no appreciable volume of vapors escaped, as was proved by passing a large torch over the foam blanket without any resultant reignition.



NOISE, piping vibration, and serious deviations from predicted compressor performance may all result if the natural frequency of a compressor piping system equals some important component of the pressure waves set up by the intermittent "puffs" of gas passing through compressor intake or exhaust valves. Analogy between these pressure waves and electrical waves has long been known. The author makes use of it in developing a method for predicting the natural frequencies of proposed compressor piping systems. He has applied the method to piping systems experimentally studied by others, and has found agreement to be remarkably close, often within one percent of experimentally determined values. He suggests, in conclusion, that support by the industry of a concerted development effort would seem well worthwhile, and he warns that "indiscriminate adding of receiver volume may well be dangerous because of lowering of natural frequency. Use of an orifice is wasteful, and may also be dangerous, . . ."

Presentation of this material was made at a recent meeting of the California Natural Gasoline Association.

Natural Frequencies of Compressor and Engine Manifolds

EUGENE F. MURPHY

Assistant Director for Research, Prosthetic and Sensory Aids Service, Veterans Administration, New York

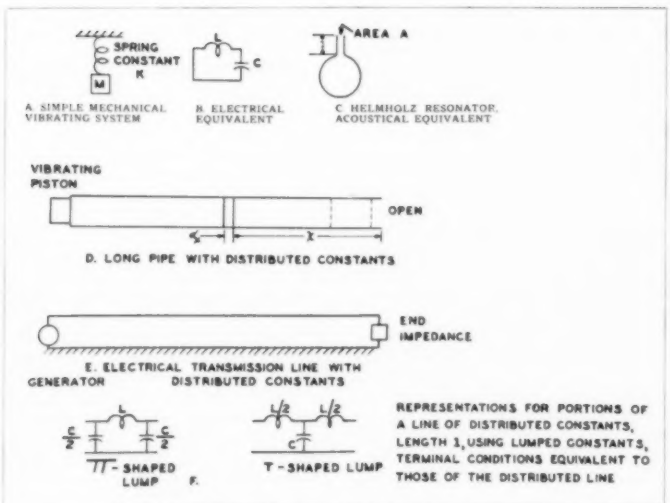


Figure 1. Analogous Systems

BUILDERS and operators of reciprocating compressors for many years have been disturbed by a number of difficulties. Some are noise, piping vibration, low or unexpectedly high capacity, low efficiency, or serious periodic vibrations in speed, called hunting. Attempts to correct these difficulties in completed full-scale plants are expensive. Such disturbances appear to be due to resonance between the natural frequency of the piping system or a portion of it and the fundamental or a harmonic of the pressure wave set up by intermittent intake or discharge of gas by the cylinder. Thus determination of the natural frequency of the piping system is necessary.

It will be recognized that these pressure pulsations within the piping may cause difficulties due to their effect upon the indicator cards or because of vibration of the piping itself as a Bourdon tube pressure gage and as a result of a change of momentum of the gas. It is emphasized that the *superimposed* oscillating component of pressure is studied, not the pressure drop due to steady flow through the system. An average pressure P_0 throughout the system is assumed.

Methods of Attack

Direct calculation is possible for simple piping systems from the usual organ pipe theory, but more complicated systems cannot readily be calculated in advance of construction. Because of the complexity of the typical compressor or engine plant piping system, the labor involved in mathematical calculation is often unwarranted. The effect of a simple change of some quantity such as manifold volume can only be determined by repeating the entire calculation. The analogy to torsional vibration or to water hammer is apparent but not directly applicable. A direct experimental attack on a small-scale model would be possible but difficult. Good indicator diagrams at speeds between 500 and 1500 rpm. are rare. Measurement of the oscillating flow of gas is also difficult. The graphical method proposed by Warming[1] seems best adapted to quick solution of simple circuits but not to solution of complex circuits or especially to trial of many proposed alternatives on complex systems since a nearly fresh start must be made for each trial and a separate diagram is needed for each branch of any complex piping system.

An electrical analogy method was originally suggested by Dean L. M. K. Boelter, now at U.C.L.A., as a convenience in visualizing the problem. Experimental use of radio capacitors, inductors, and an oscillator at audio or

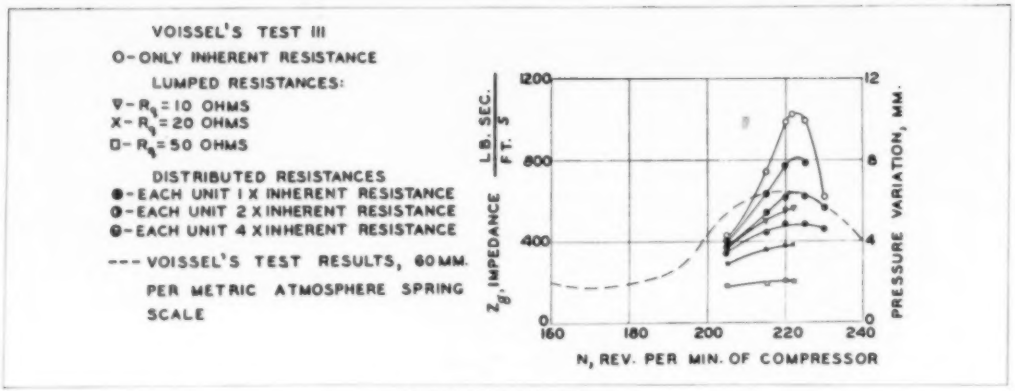


Figure 2. Effect of Resistance

radio frequencies appeared possible. The difficulties of changing wiring, the relative scarcity of readily variable accurate capacitors and inductors, the relatively large impedances of the connecting lines, and the possibilities of interference made this direct attack seem impracticable. Installation of an a.c. network calculator by the Armour Research Foundation of Illinois Institute of Technology made direct experimentation seem feasible.

The electrical analogy seemed desirable as a direct attack on an electrical network calculator of the type used for solving alternating current transmission line problems. In contrast to direct experiment, the electrical method permitted simple, safe, and accurate measurement by a single observer of the electrical potential difference or voltage, the current, and other quantities in a stable and easily adjusted system of any complexity. A given electrical circuit with definite numerical values actually represented a variety of acoustical systems, tending toward generalization of the problem. The use of an electrical analogy for an acoustical system is not original. Olson,[2] for example, presents a number of analogies. The use of the a.c. network calculator for *direct* experimental attack seems new.

Development of the Analogous Circuit

Any analogy between comparable systems depends upon the fact that behavior of each system is described by equations of the *same form*. The analogy used here depends upon substitution of electrical terms for the corresponding elements in differential equations derived for the acoustical system. The derivation made the usual assumptions of small pressure fluctuations from an average value, a continuous medium without shock waves, stiff and unyielding pipe walls, etc. The present analogy, as used experimentally, neglected the effect of resistance or damping upon the resonant frequency. Therefore, no attempt was made to predict actual pressure or velocity fluctuations.

The analogy between *lumped* mechanical, acoustical, and electrical systems is well known. The corresponding analogy in the case of a distributed system, while recognized, does not seem to have been used experimentally. Figure 1 shows three simple, idealized, lumped systems. Friction or resistance and driving forces are neglected in each case. The respective differential equations are well known. Derivations are briefly outlined in the Appendix.

Several relationships are possible, but for convenience in visualizing the problem and in selecting the ranges of elements which are physically available, oscillating pressure (about an average pressure) has been replaced by alternating electrical potential, and rate of oscillating gas flow or volume current by alternating electrical current. Then the inertia of the gas may be visualized as comparable to the inductance. The spring effect of a volume of gas (into which more may be packed by raising the pressure) is replaced by a condenser or capacitor, on which more electrical charge can be stored by raising the voltage.

Equations for long pipe lines with distributed parameters or properties are derived in different ways in various text books on acoustics and in a thesis by Reinhardt.[3] The final equations for motion show the same values for inertance and capacitance when compared with the equations for electrical transmission lines with distributed inductance, capacitance to ground, and resistance.

Electrical texts then show that the uniformly distributed parameters can be replaced, so far as the effects at the terminals are concerned, by lumped or grouped parameters arranged in pi or T-shapes as shown in Figure 1. For the pi-shaped lump, all the inductance in the line segment considered is gathered into a single inductor. All the distributed capacitance to ground is replaced by two capacitors, each half of the total distributed capacitance, connected from either side of the inductor to ground. Alternatively, the T-shaped lump splits the total inductance but combines all the capacitance. The two circuits are equivalent.

For adequate engineering accuracy the higher terms of the hyperbolic functions for the exact replacement can be neglected, provided the segment considered is less than 1/20th to 1/10th of a wave length at the frequency under consideration. Lumps three to ten feet long are often suitable in dealing with engines or compressors.

Simplification of System

A consideration of the boundary conditions for the lumps shows that adjacent segments of a plain cylindrical pipe can be joined end to end. The adjacent capacitors may then be added and combined into a single capacitor. A similar process can be carried out at changes of cross-section, as from a small pipe leading into a header.

Certain components of predominantly one type of parameter, either capacitance or inductance, can often be represented by single lumps or even combined with the adjoining lumps. The acoustical inertance, analogous to electrical inductance, varies inversely as the cross-sectional area of the pipe, while the acoustical (and analogous electrical) capacitance varies directly with that area. Thus short sections of large diameter as com-

pared to the rest of the system, such as manifolds or receivers, are analogous to nearly pure capacitors. If the small inductance is neglected entirely, the pi-shaped lump can be simplified to a single large capacitor which in turn can be added to the capacitors of the adjoining pi-shaped lumps to form as a single still larger capacitor. The total number of electrical units needed on the calculator is thus reduced. In general as many capacitors as inductors are necessary.

Termination of Line

An open pipe can be shown to correspond to an electrical short circuit, since pressure disturbances are immediately dissipated. At a capped or closed end the piping system is cut off, pressure can fluctuate, but no further disturbance is possible beyond that point. Correspondingly an open end of the electrical circuit, without connection between the line carrying the potential and the ground, prevents electrical current from flowing further but permits potential to exist between the line and ground and permits reflection of waves. An infinitely long line can be replaced by its "surge impedance" just as an infinitely long electrical transmission line. This impedance is a pure resistance connected from the line carrying the potential to the ground. No reflections will occur from such an impedance since it is equivalent to a line through which the disturbance passes indefinitely without returning.

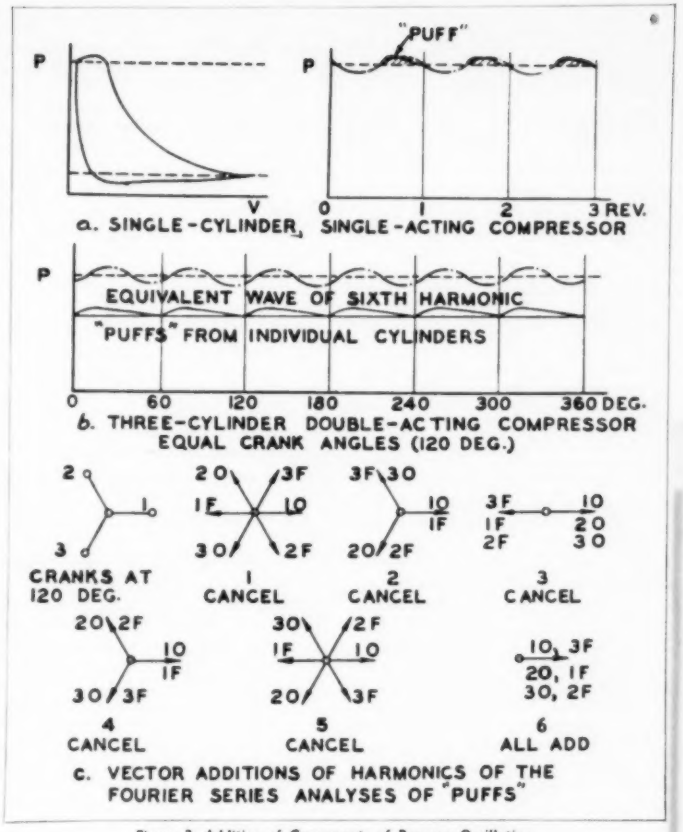


Figure 3. Addition of Components of Pressure Oscillation

Resistance Neglected

In the calculations for most of the cases studied in the thesis and compared with practical experiments, resistance was neglected. A considerable number of cases included engine and compressor intake and discharge lines, some including surge chambers. The *natural frequencies* of the piping systems as determined by the electrical analogy coincided within one or two percent with those determined experimentally on the actual piping systems.

To estimate, to a certain extent, the effect of resistance, electrical resistance was arbitrarily added in a circuit corresponding to Test III on a compressor intake by Voissel.[4] It will immediately be recognized that acoustical pressure drop varies as the *square* of velocity, whereas the electrical voltage varies only *directly* as the electrical current. The analogy thus does not truly hold for resistance, if a simple resistance element is used. (Since the experimental work for this paper was conducted, several multiplier systems have been described by Harder and McCann.[5] Their use, however, does not seem necessary for this purpose since for natural frequencies such satisfactory agreement was obtained with the complete neglect of resistance. No attempt was made to predict extent of pressure or velocity variation.)

As shown in Figure 2 the addition of resistance, either as a lump at one point in the electrical circuit corresponding to the piping system or distributed throughout the circuit, merely lowers and flattens the resonance curve with only a slight downward shift of the natural frequency. As a matter of fact, addition of considerable resistance makes the electrical resonance curve more nearly resemble that obtained on the practical acoustical system.

Relationship Between Natural Frequency and Engine or Compressor Speed

A Fourier series analysis might be made of the resultant pressure disturbances due to the train of "puffs" of gas or air in the pipe line immediately adjacent to the machine. The relative magnitudes of the fundamental and the various harmonics of the irregular "puff" due to one end of one cylinder will depend on many factors, such as piston action, relation of sizes of valve, pipe, and cylinder, valve opening speed and pressure at that time, etc. Fortunately, knowledge of the exact wave shape is unnecessary for practical purposes.

As shown in Figure 3 a crude picture may be obtained by considering the "puff" from the indicator card when replotted on a time basis.

If more than one cylinder end pumps into or from a given piping system, the appropriate harmonics can be added by vector diagrams, as in Figures 3 and 4. The most serious disturbance will occur for resonance between the natural frequency in a given mode of vibration and a harmonic yielding the maximum vectorial sum of the harmonics of waves due to the "puffs" from the individual cylinders. Less serious and often negligible vibration will occur for resonance be-

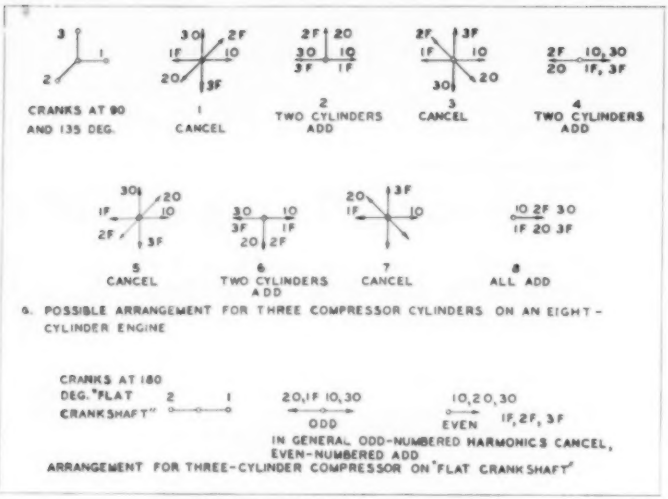

CRANKS AT 90 AND 135 DEG.
1 CANCEL
2 TWO CYLINDERS ADD
3 CANCEL
4 TWO CYLINDERS ADD
5 CANCEL
6 TWO CYLINDERS ADD
7 CANCEL
8 ALL ADD
6. POSSIBLE ARRANGEMENT FOR THREE COMPRESSOR CYLINDERS ON AN EIGHT-CYLINDER ENGINE
CRANKS AT 180 DEG. "FLAT CRANKSHAFT"
ODD
EVEN
IF, 2F, 3F
IN GENERAL ODD-NUMBERED HARMONICS CANCEL, EVEN-NUMBERED ADD
ARRANGEMENT FOR THREE-CYLINDER COMPRESSOR ON "FLAT CRANKSHAFT"

Figure 4. Vector Additions, Other Arrangements

tween a natural frequency and other harmonics which add to lower values.

Comparison of Figures 3 and 4 shows that the number of the harmonic whose vectors are parallel and in the same direction, and hence add directly, is not necessarily the sum of the number of cylinder ends. If the impulses are uniformly spaced, their sum equals the number of cylinder ends and indicates the number of the important harmonic. However, irregular firing orders or spacing of cylinders should be studied by means of the vector diagrams, as in Figure 4. The relative importance of eight times the eighth harmonic compared to only twice the sixth harmonic for such a three-cylinder, double acting machine will depend on the shape of the "puffs." The engine crankshaft should be designed from this viewpoint as well as other considerations, such as firing order, stress, and torsional vibration. An estimate may often be obtained by superimposing arbitrary shapes of "puffs" from the cylinder in their proper timing and noting the frequency of the major ripple in the sum of the waves.

Calculation of Impedance of the Acoustical Prototype and of the Calculator

For the acoustical system the properties of the gas at an average pressure P_a and temperature are presumed to be known. In the case of high pressure compressors the super-compressibility of the gas should be considered. The value for the ratio of specific heats should also be obtained for the pressure and temperature which will actually be encountered. Acoustical inertance and capacitance for the various segments of pipe line can be readily calculated, preferably in tabular form. Suitable sections or lumps are usually the length from cylinder to manifold, the complete manifold, and sections of 1/20th or even, with good accuracy, 1/10th of a wave length in the main discharge pipe. The wave length, of course, is that corresponding to the suspected harmonic of the operating speed of the compressor for which the vector diagram shows disturbance may occur.

The acoustical impedance Z_a is the pressure divided by the volume current in consistent units. The relationship between the acoustical and the electrical systems is then defined in terms of an arbitrarily chosen scale factor F_s.

For the particular calculator used, with an operating electrical frequency of 440 cycles per second, the inductive reactance was directly calibrated on the dial. The capacitors, however, were calibrated in micro-farads.

Combining Cylinders

The process of adding units is shown in Figure 5. In the box are shown first a three-cylinder compressor discharging into a manifold, then the same system with the manifold considered as a lumped volume or sphere with three parallel cylinders discharging into it, then an equivalent single cylinder discharging through separate passages into this sphere. It will be recalled that under the critical conditions at which serious resonance will occur, usually all the harmonics are in phase, and therefore the cylinders act as though they were one with all pressure waves in phase. The corresponding electrical networks are shown in the bottom of the box, although the very elaborate network corresponding to a distributed manifold is omitted because of lack of space. Around the top and right side of the box is shown the equivalent network. For a practical piping system the three parallel and equal inductors of the last circuit in the box are combined as a single inductor of value 1/3 of any one of the three. The three parallel capacitors are combined as a single capacitor—equal to the sum of the three. Then the capacitors on the right side of the first pi-shaped lump and the left of the next are added and combined. The final result is an electrical system which looks as if it applied to a simple straight organ pipe. The numerical values of the first few units corresponding to the small pipes from cylinders to the manifold and to the manifold itself are not equal to the values for adjacent elements of plain pipe to the header.

This result indicates that a *generalized* system could readily be tested with systematic variation of the first few inductors and capacitors in comparison to the remainder to give the effect of variation in manifold size and volume. Some preliminary experiments of this nature were in fact performed very simply and rapidly.

Effect of Varying Frequency and Speed

The network calculator is operated at a constant frequency, say 440 cycles per second. The effect of varying acoustical frequency, corresponding to resonance with a new compressor speed, was obtained by varying the scale factor F_s and the inductive reactors on the calculator X_L, leaving the capacitors at base values which were originally calculated for an arbitrarily chosen acoustical frequency. The inductive reactance varies as the square of the speed ratio while the scale factor varies directly with the acoustical frequency.

An alternative method varies the electrical frequency supplied to the calculator, leaving the inductors and capacitors at their initial setting. This method was also followed successfully. Consideration must be given to possible errors in the meters at variable frequencies for which the calculator was not originally designed.

Nature of the Calculator

The a.c. network calculator consists of calibrated and adjustable inductors, resistors, and capacitors, like enlarged radio parts. These can be combined in any desired arrangement by means of cord banks and plug boards which permit connection as simply as plug-

ging a lamp into a base plug. The main metering desk is rapidly connected to any desired circuit element by small relays selected by push buttons on the desk, somewhat like dialing a telephone. The meters are operated by electronic amplifiers so that the drain upon the system and consequent distortion due to insertion of the meters themselves is negligible. They are in general more accurate and certainly are easier to use than equivalent acoustical devices, such as indicators or flow meters. They can be connected at any desired point in the system far more easily than pressure taps and orifice plates could be inserted in an actual piping system.

The generator used to represent compressors or engines is not a rotating device but rather a phase shifter or a set of coils. To determine *natural frequency* of a piping system only one generator was necessary. In this study a solution for steady state forced and natural vibration was sought. It is also possible, however, to apply transient potentials of arbitrary forms and to photograph the resulting wave forms on an oscillograph.

The highest value of impedance at the generator end Z_g, was used as a measure of resonance with the applied electrical frequency and hence of the natural frequency of the equivalent acoustical system. The highest impedance indicated the greatest range of pressure oscillation for a given volume current oscillation applied by the fixed piston motion. The effect upon the pressure within the cylinder during valve opening in the actual acoustical system would then be a maximum. These observations were confirmed by the pressure-time diagrams in the studies by Voissel[4] on the intake to a compressor and by Farmer[6] on diesel engines.

Because of the high first cost needed to obtain operating simplicity, few companies can afford to own a calculator. It is usually more practicable to participate in a cooperative agreement with other prospective users or to rent operating time on an existing calculator, of which well over a dozen are available in the country. The work reported here was done at Illinois Institute of Technology. In the near future U.C.L.A. will have a smaller, but adequate, calculator.

Results

The electrical analogy method was checked against reported natural frequencies of actual intake or discharge systems of compressors and engines containing air or exhaust gas, with temperatures from room to several hundred degrees. Tests included two and four-stroke cycle engines and single and double-acting compressors operating at 120 to 1200 rpm., in various combinations. The analogy method also agrees with Warming's graphical method shown in Figure 6, both on his examples and on hypothetical cases.

A three-cylinder, double-acting compressor was studied extensively, but not included in the thesis. Tests on the calculator indicated severe vibration increasing from 1560 to 1830 vibrations per minute, with a peak vibration in a complex mode at the latter value. This was almost exactly six times normal compressor speed, 300 rpm. A vibrometer held against the discharge piping showed increasingly severe vibration of these same frequencies, always six times engine speed. Recent information, however, confirms a crankshaft arrangement of the eight-cylinder engine which would give 45-degree spacing, somewhat resembling Figure 4, with harmonics from only two cylinders adding at six times engine speed, but all cylinders adding at eight times speed. One can only speculate, without further test, as to whether twice the sixth harmonic would exceed eight times the eighth. No tests were made on the calculator at frequencies corresponding to eight times normal operating speed range. Further study of this particular case is indicated, although the general method seems entirely sound.

For prediction of natural frequencies within two percent, and usually less, only the inertance and capacitance of the system, calculated by essentially acoustical methods, need be considered. The discrepancy in pressure drop due to resistance, large variations of pressure compared to the mean, shock waves, the effects of bends, and the end effect of open pipes and sudden changes in pipe diameter may be neglected.

The analogy as used here does not yield quantitative values for pressure variations although they are qualitatively comparable to observations of relative pressure variations on the acoustical systems. Resistance, comparable to an orifice, lowers voltage (and pressure) variation, but resists direct as well as oscillating flow, wasting energy.

Either T-shaped or preferably pi-shaped lumps may be used to represent segments of piping. Some tests indicated that they may be 1/10 of a wave length with less than 1 percent error in the resonant frequency.

Generalized Systems

An increase in shunt capacitance between the line and ground, equivalent to increase in receiver volume, *lowers* the natural frequency of the system but decreases the impedance, comparable to decreasing the pressure variations in a practical piping system with constant piston motion. Capacitance near the generator, or receiver volume nearer the piston, is more effective in producing these changes. An orifice, because of its small cross-sectional area, adds inductance as well as resistance and hence lowers natural frequency.

The addition of a capped branch pipe at any point along the line also lowers the natural frequency of the system and has greater effect when it is nearer to the compressor. The total of branch plus direct pipe exceeds the length of direct pipe alone needed for a given natural frequency.

Conclusion

It is thus seen that the natural frequency of a piping system can be

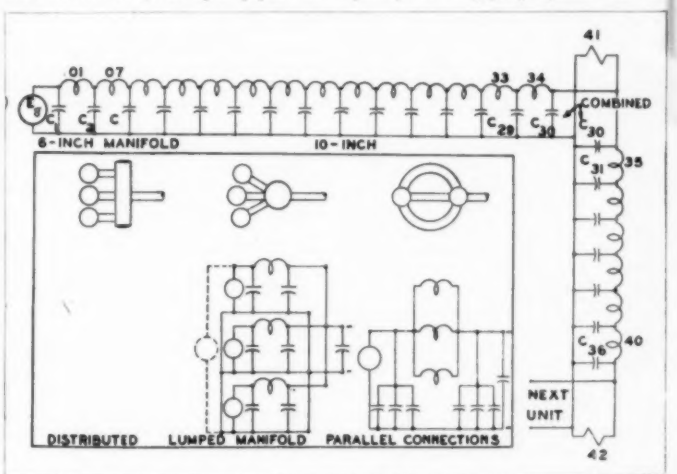


Figure 5. Lumped Manifold Arrangement 14, Three-Cylinder Natural Gas Compressor

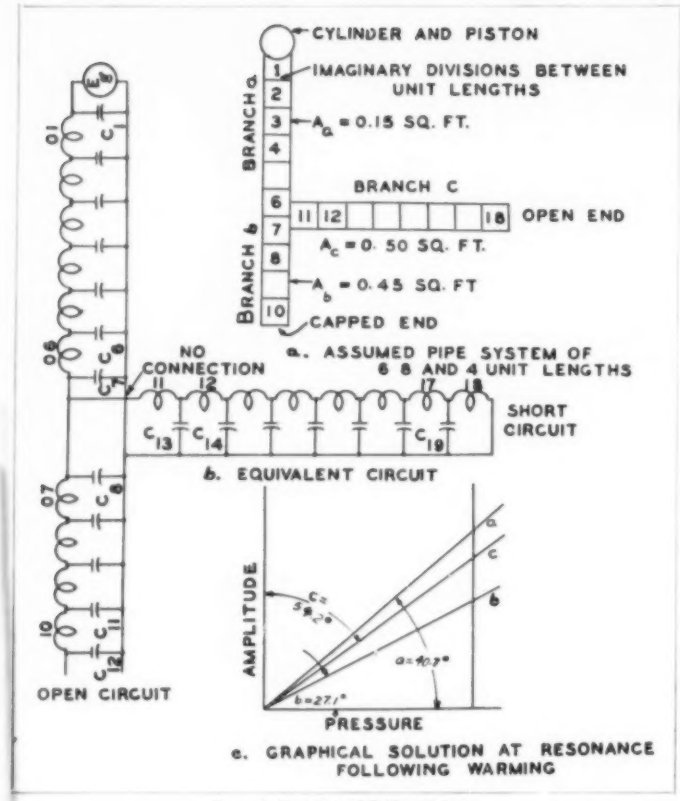


Figure 6. Hypothetical T-Shaped Pipe

predicted, resonance with the harmonics of "puffs" from the cylinders can be foreseen, and the effects of variation in manifold volume or pipe length can be predicted inexpensively in the design stage. Indiscriminate adding of receiver volume may well be dangerous because of lowering of natural frequency. Use of an orifice is wasteful and may also be dangerous, but an impedance—capacitance filter comparable to a low-loss muffler can easily be designed by simple experiments. Support by the industry of a concerted development of design criteria in the form of results on generalzied system would seem worth while.

ACKNOWLEDGEMENTS

The author is deeply indebted to Dean L. M. K. Boelter of U.C.L.A., Dean W. A. Lewis, Mr. Henry McGreer and Dr. Lloyd Donnell of Illinois Institute of Technology, and many friends in the compressor and gas industries.

APPENDIX

Differential Equations

With resistance and driving force neglected, the spring force applied to the mass in Figure 1 equals the mass times its acceleration. The force F due to the spring, $-kx$ or $-k\int v\,dt$, is directed back toward the neutral position. (If the system is not horizontal, the effect of gravity balances out if the neutral position is that of equilibrium with the weight on the spring.)

$$F = -kx = -k\int v\,dt = Ma = M\frac{dv}{dt}$$

$$M\frac{dv}{dt} + k\int v\,dt = 0 \qquad (1)$$

Various electrical engineering texts show, usually from energy considerations, that in the simple circuit in Figure 1:

$$E = L\frac{di}{dt} + \frac{1}{C}\int i\,dt = 0 \qquad (2)$$

In the acoustical case of the Helmholz resonator, a plug of gas in the neck of a flask can be considered to be the mass. This then is the average density ρ_0 times the volume of the plug, or its length (l) multiplied by the cross-sectional area (A) of the neck. With considerable calculations based on the laws of thermodynamics, the restoring force due to the spring effect of the volume (V) of gas in the flask can be shown to be:

$$F = -P_0\gamma\frac{A^2x}{V} \qquad (3)$$

Here P_0 = average absolute pressure

γ = ratio of specific heats and exponent for adiabatic compression; consideration should be given to any effect of super-compressibility.

x = displacement of the plug of gas.

Then in terms of the volume current I, or particle velocity times area, the usual form of Newton's Law or Equation 1 can be rewritten as:

$$\frac{\rho_0 l}{A}\frac{dI}{dt} + \frac{P_0\gamma}{V}\int I\,dt = 0 \qquad (4)$$

Comparison of Equations 1, 2, and 4 shows the same general *form* if the meaning of the symbols is changed. This condition is termed *analogous*. (Thus, $mx - b = 4$ and $ny - c = 6$ are of the same form, linear equations, and might describe analogous conditions, but $x^2 - bx^2 - cx = 4$ would be an entirely different *form* of equation.)

Acoustical and Electrical Values

Comparison of Equations 2 and 4 indicates that certain acoustical properties, determined by the average properties of the gas and the dimensions, may be combined to give the equivalents of inductance and capacitance.

$$\text{Acoustical Impedance } L_a = \frac{\rho_0 l}{A} \qquad (5)$$

$$\text{Acoustical Capacitance } C_a = \frac{V}{P_0\gamma} \qquad (6)$$

The particular network calculator used had inductive reactance units calibrated directly in terms of the inductive reactance (X_c) for the calculator frequency, $f_c = 440$ cycles per second. Then for a given acoustical case the base acoustical frequency corresponding to that calculator frequency is mN, or the number of the harmonic whose vector diagrams shows a maximum addition of the harmonics of the individual cylinders times the desired base engine or compressor speed.

$$\text{Inductive Reactance } X_c = F_s\frac{2\pi}{60}\,m\,N\,\frac{\rho_0 l}{A} \qquad (7)$$

It will be recalled that the scale factor F_s can be chosen at will. Integral values between one and ten were found convenient for all cases studied.

The capacitors were calibrated in microfarads, so:

$$\text{Calculator Capacitance } C_c = \frac{m\,N}{60\,F_s\,f_c}\,\frac{Al}{P_0\gamma} \times 1{,}000{,}000 \qquad (8)$$

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[4] Voisael, Peter—"Renonanzerscheinungen in der Saugleitung von Kompressoren und Gasmotoren," (Resonance Phenomena in the Suction Line of Compressors and Gas Engines.) Mittellungen ueber Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, Heft (Vol.) 106 (1911) Verein deutscher Ingenieure, Berlin, pp. 27-59 plus 5 Tables.

[5] Harder and McCann—"Development of Analog Computer," Conference Paper, AIEE, Pittsburgh Meeting, January 26, 1948.

[6] Farmer, Harry O.—"Exhaust Systems of Two-Stroke Engines," Proc. Instn. of Mech. Engrs., Vol. 138 (1938), pp. 367-90 disc. 391-413.

The Economics of Motor Voltage Selection

PART II

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Electrical Engineer, Utilities Department, Houston Refinery, Shell Oil Company, Inc.

IN PART II of this article, the author completes an extensive discussion of the theoretical and practical advantages and disadvantages of several voltages—440, 2400, and 4160—for electric motors used in process plants.

Among conclusions drawn, is that on the basis of direct and indirect costs, motor installations up to and including 100 horsepower can be more economically accomplished by using 440 volts.

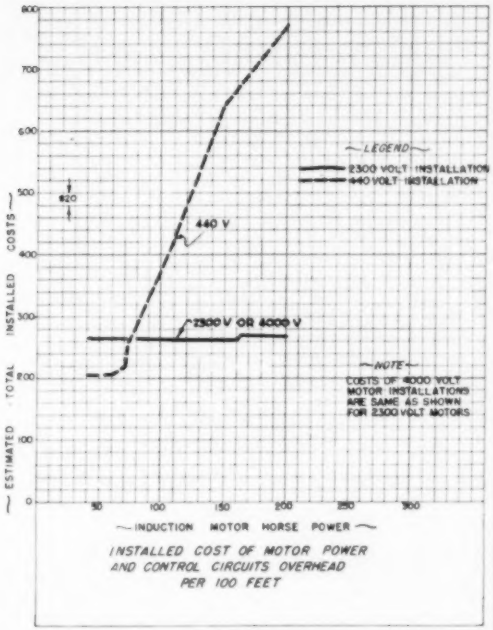

LEGEND
2300 VOLT INSTALLATION
440 VOLT INSTALLATION
440 V
2300 V OR 4000 V
NOTE
COSTS OF 4000 VOLT MOTOR INSTALLATIONS ARE SAME AS SHOWN FOR 2300 VOLT MOTORS
ESTIMATED TOTAL INSTALLED COSTS
INDUCTION MOTOR HORSE POWER
INSTALLED COST OF MOTOR POWER AND CONTROL CIRCUITS OVERHEAD PER 100 FEET

FIGURE 15

IN THE economics of motor voltage selection, consideration must be given to the numerous factors ranging from the power distribution system to an evaluation of the reliability of the completed motor installation. More than the lowest initial equipment cost must be considered, as shown in Part I (PETROLEUM REFINER, May, 1949); minimized maintenance and the highest degree of reliability consistent with the requirements of the specific installation are involved, also.

As discussed in Part I, the primary distribution voltages usually found in industrial plants, which cover an appreciable area, are 2400, 4160, and 13,800 volts. The voltage used is a function primarily of load density and individual motor ratings, when factors such as precedence and special considerations can be waived.

Variable Factors of Motor Installations Costs—(Group 2)

Distribution System Primary Voltages

As Part I mentioned, several voltages are used for primary distribution in industrial plants; namely, 2400 volts, 4160 volts and 13.8 kv. Each of the distribution voltages listed has its own particular field of application as concerns its effect on the economics of motor voltage selection. If it is presumed from the foregoing discussions that motors over 100-hp. can be more economically served from 2400 or 4160-volt distribution systems, it is apparent that the final choice of a primary voltage is extremely important. It is often the case that a large percentage of the installed motor horsepower in a plant is represented by motors larger than 100-hp. and will consequently be served directly from the distribution system.

When considering motors larger than 100 hp. the use of a 2400-volt primary distribution system has the advantages, subject to certain qualifications, of initial motor installation economies, when compared with either a 480 or 4160-volt system. However, for these economies to be entirely applicable, it is necessary that transmission distances be short and that the number of motors larger than 100-hp. be a large percent of the connected motor load. In "Electric Motors in Industry," by Shoults, Rife and Johnson, this statement appears. *The 2200-volt circuit is generally the most desirable up to about 10,000 kva. total load, since the higher voltages introduce greater hazard and require higher insulation values on motors.* Obviously, power distribution distances must be short otherwise the cost of the high-current power channels would adversely affect the savings realized from using 2300-volt motors and equipment.

One of the principal limitations to the use of 2400-volt distribution is the short circuit duty imposed on the source buses. Upon reaching a short-circuit interrupting level of about 130,000 kva. the momentary current requirements will be in the order of 50,000 amperes and any further increase incurs considerable additional cost for switchgear. In order that the momentary current loadings will not exceed 50,000 amperes, it is necessary to limit the bus power load capacity to approximately 6000-7500 kva. This limitation urges consideration of higher voltages when greater concentrations of load would require additional source buses or higher interrupting capacity switchgear.

The 4160-volt distribution system is continually gaining favor when compared with a 2400-volt system. This is particularly true when circuit lengths are in the order of 3500 feet or when heavy feeder circuit loadings are desirable. A recent article states, *Operation of feeder circuits at 4000 rather than 2300 volts indicates a saving of about $1.00 per circuit kva. per 1000 feet.* ("Economic Advantages of Higher Industrial Voltages," by R. H. Kaufmann in General Electric "Distribution," July, 1947.) Additional savings result from the fact that for the same interrupting capacities, 4160-volt feeder switchgear is equal or less costly than 2400-volt equipment. Also, whereas

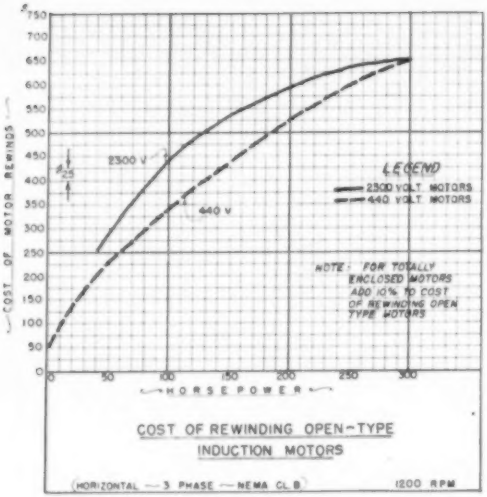

COST OF MOTOR REWINDS
2300 V
440 V
LEGEND
2300 VOLT MOTORS
440 VOLT MOTORS
NOTE: FOR TOTALLY ENCLOSED MOTORS ADD 10% TO COST OF REWINDING OPEN TYPE MOTORS
HORSEPOWER
COST OF REWINDING OPEN-TYPE INDUCTION MOTORS
(HORIZONTAL — 3 PHASE — NEMA CL B) 1200 RPM

FIGURE 16

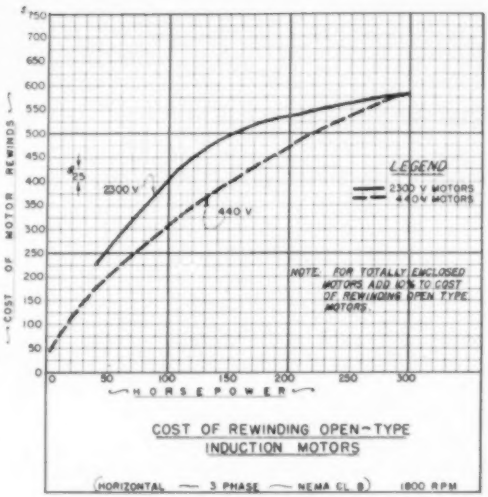

COST OF MOTOR REWINDS
2300 V
440 V
LEGEND
2300 V MOTORS
440 V MOTORS
NOTE: FOR TOTALLY ENCLOSED MOTORS ADD 10% TO COST OF REWINDING OPEN TYPE MOTORS
HORSEPOWER
COST OF REWINDING OPEN-TYPE INDUCTION MOTORS
(HORIZONTAL — 3 PHASE — NEMA CL B) 1800 RPM

FIGURE 17

2400-volt system source buses are limited to approximately 7000 kva. for greatest over-all system economy the 4160-volt system admits an increase up to 12,500 kva. capacity with some switchgear economies, the latter resulting from fewer primary feeder positions being required. Forty-one hundred sixty-volt like 2400-volt distribution systems becomes unwieldy with even moderate loads when transmission distances become excessive and under these conditions considerations of a higher voltage must be entertained.

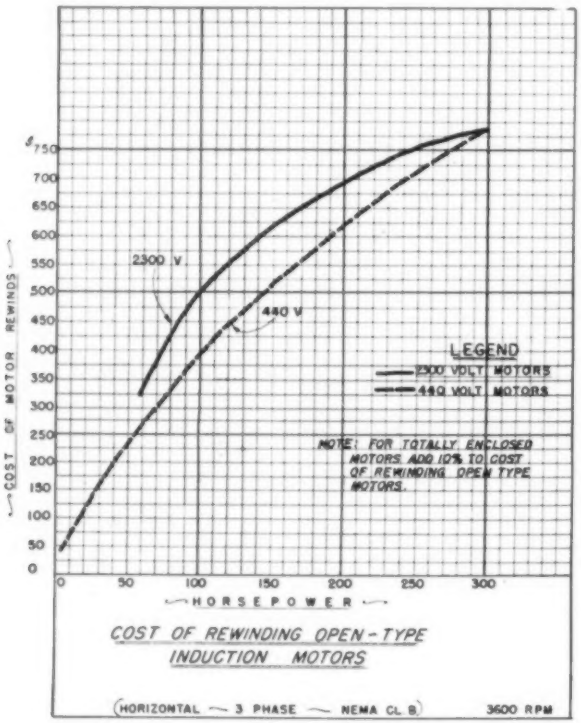

COST OF MOTOR REWINDS
2300 V
440 V
LEGEND
2300 VOLT MOTORS
440 VOLT MOTORS
NOTE: FOR TOTALLY ENCLOSED MOTORS ADD 10% TO COST OF REWINDING OPEN TYPE MOTORS.
HORSEPOWER
COST OF REWINDING OPEN-TYPE INDUCTION MOTORS
(HORIZONTAL — 3 PHASE — NEMA CL B) 3600 RPM

FIGURE 18

The use of 13.8-kv. distribution is generally limited by economics to systems involving large loads and long distribution circuits. These economic limitations have been summarized by Kaufmann of General Electric as follows: *For plants having large electric-power loads or extensive geographic distribution (say more than 20,000 kva. and distribution distances of more than 4000 feet), the adoption of 13,800 volt distribution may be expected to result in the best economy.*

Interrupting ratings of 13.8-kv. switchgear in the magnitude of 500,000 kva. are economically feasible with 13.8-kv. distribution. This interrupting capacity rating permits the power bus to be economically designed for 40,000 to 50,000 kva. when so required.

Summarizing the considerations of primary distribution voltages which directly determines the voltage of the large motors, it appears:—

a) That when motors larger than 100 hp. are very compactly located and, in addition, constitute a sizable block of the connected motor load, 2400-volt distribution is generally feasible.

b) That 4160 volts will in general be the most economical voltage for plants having connected motor loads of approximately 10,000 to 20,000 kva., inasmuch as large motors can be connected directly to the system and, in addition, improved distribution system economies will result.

c) That 13.8-kv. distribution is economically feasible when connected motor loads approach

20,000 kva. and when distribution distances become in the order of 4000 feet.

Switch Rack Buses and Switch Houses

The installation costs of switch rack buses and connections to the motor controllers increase with the voltage. Considering motor installations between 60 and 125 horsepower, a proportion of the 2300-volt bus and the controller connections will cost approximately $125 more per motor serviced than a similar 440-volt installation. For estimates of the installation costs of explosion-proof switch rack buses for 440-volt and 2300-volt motors refer to Kun's "Motor Voltage Considerations in Oil Refineries," PETROLEUM REFINER, February, 1946.

As would be expected 2300 and 4000-volt switch rack bus and motor controller installations require more space than an equivalent 440-volt installation. This factor is of considerable importance when switch racks are located in substantial buildings of fire resistant materials and may amount to a difference in the allocation of building costs per motor controller of as much as $200 per controller.

It is apparent that the cost of switch rack bus construction and the space requirements of motor controllers in general favors 440 volts as compared with 2300 or 4000 volts. It may affect the motor installation costs to the extent of rendering a more favorable comparison of 440 with 2300 volts at the 125 hp. rating. (Refer to Figures 12, 13 and 14.)

Motor Feeder Cables and Conduits

The installed cost of 440-volt motor feeder and control cables and conduits is generally greater than for 2300 or 4000-volt installations. This is entirely a function of the heavy currents and consequently larger conductors and conduits coincident with low voltage. A comparison of the cable and conduit costs for 440, 2300, and 4000 volts is shown in Figure 15. Note that for motor sizes of 100 and 125 hp. 440-volt installations cost approximately $175 more for a 100-foot circuit length than equivalent 2300 and 4000-volt installations.

Present planning is such that switch racks, or motor control centers as the case may be, are located close to load centers and as a result motor feeder runs are short and their effect on the economics of motor installations is greatly reduced. Sometimes, however, special considerations adversely affect the length of motor leads, such as when motor controls serving motors in a hazardous area are controlled from a nonhazardous area at some distance from the motors.

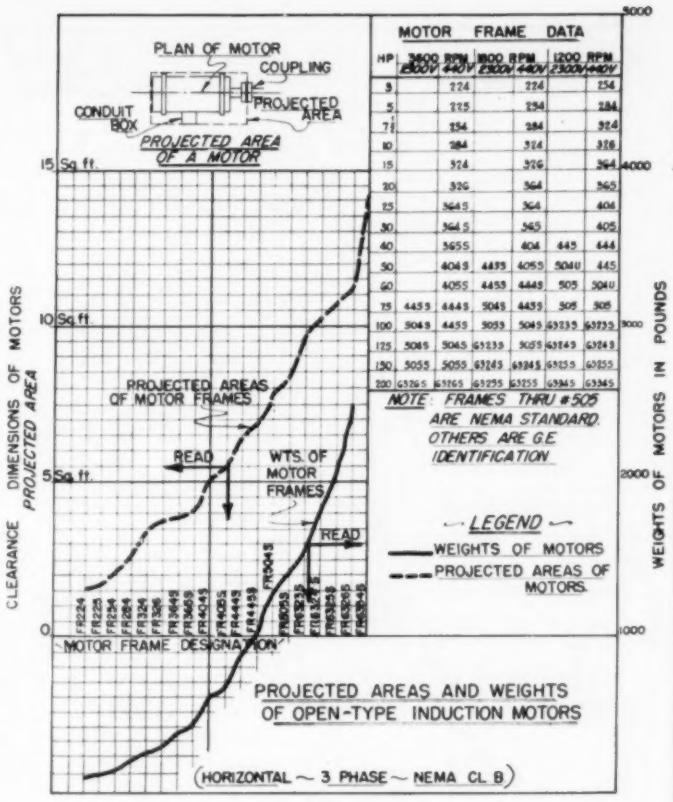

PLAN OF MOTOR
COUPLING
CONDUIT BOX
PROJECTED AREA
PROJECTED AREA OF A MOTOR
15 Sq. ft.
10 Sq. ft.
5 Sq. ft.
0
CLEARANCE DIMENSIONS OF MOTORS PROJECTED AREA
PROJECTED AREAS OF MOTOR FRAMES
READ
WTS. OF MOTOR FRAMES
READ
MOTOR FRAME DESIGNATION
WEIGHTS OF MOTORS IN POUNDS
5000
4000
3000
2000
1000
MOTOR FRAME DATA
HP | 3600 RPM 2300V | 3600 RPM 4400V | 1800 RPM 2300V | 1800 RPM 4400V | 1200 RPM 2300V | 1200 RPM 4400V
5 | 224 | 224 | 254
7½ | 254 | 284 | 324
10 | 284 | 324 | 326
15 | 324 | 326 | 364
20 | 326 | 364 | 365
25 | 3645 | 364 | 405
30 | 3655 | 365 | 405
40 | 3655 | 404 | 445 | 444
50 | 4045 | 4035 | 4055 | 5040 | 445
60 | 4055 | 4455 | 4445 | 505 | 5040
75 | 4453 | 4443 | 5045 | 4453 | 505 | 505
100 | 5049 | 4455 | 5059 | 5045 | 63255 | 63255
125 | 5045 | 5045 | 63259 | 5059 | 63245 | 63245
150 | 5055 | 5059 | 63245 | 63245 | 63255 | 63255
200 | 63265 | 63265 | 63255 | 63255 | 63345 | 63345
NOTE: FRAMES THRU #505 ARE NEMA STANDARD. OTHERS ARE G.E. IDENTIFICATION
LEGEND
WEIGHTS OF MOTORS
PROJECTED AREAS OF MOTORS
PROJECTED AREAS AND WEIGHTS OF OPEN-TYPE INDUCTION MOTORS
(HORIZONTAL — 3 PHASE — NEMA CL B)

FIGURE 19

Review of Fixed and Variable Installation Costs—(Groups 1 and 2)

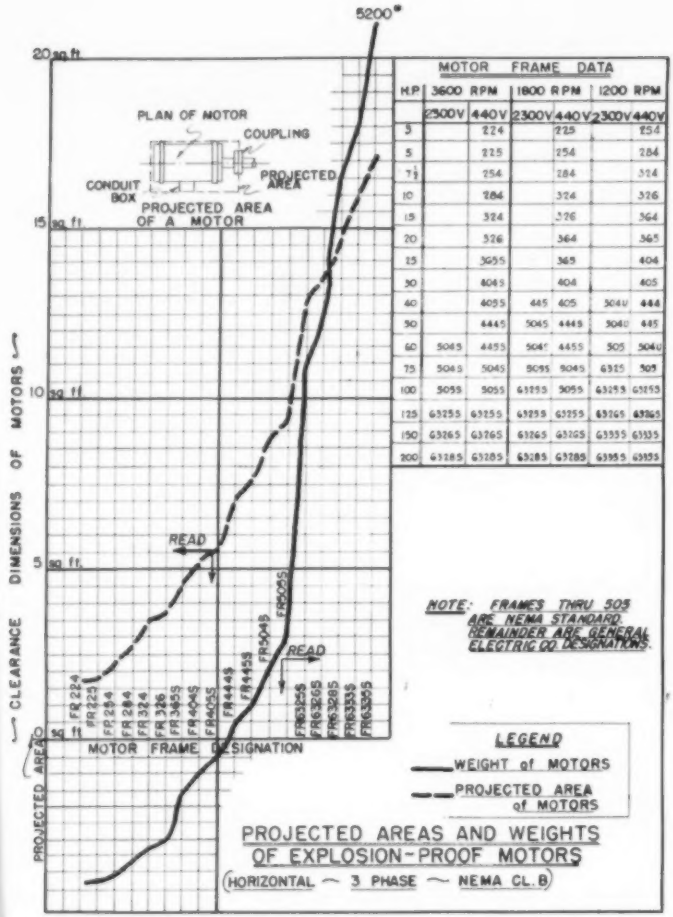
The comparison of equipment installation costs including the motor, motor controller, 480-volt substation and switch racks indicate that up to approximately 100 hp. a 440-motor installation could be made with greatest economy when compared with 2300 or 4000-volt motor installations.

For motors above 100 hp. both 2300 and 4000-volt motor installations have definite advantages. To determine which of these voltages is economically preferable requires a careful analysis of each voltage system. In addition a complete knowledge of the percentage of motors likely to be serviced directly from the system and also how these motors are geographically located is required. In general, the following factors favor 2400-volt distribution: high load densities of large motors; short transmission distances; a desire for light circuit loadings; short circuit interrupting levels not exceeding 125,000 kva.; and the use of 13.8-kv. for plant distribution. Medium power requirements (10-20,000 kva.), scattered loads and low percentages of large motors favor 4000 volts as the distribution voltage best suited to the system.

The use of 2300 or 4000-volt motors incurs, when compared with 440-volt installations, greater space requirements for the installation of motor controllers and also incurs a higher cost bus construction in the motor sizes being considered. These considerations favor the use of 440 volts for 100 and 125-hp. motors except that these economies are in part offset by the higher cost of 440-volt motor feeders. The latter has been minimized by locating the motor and control as close together as feasible.

Maintenance Considerations

One measure of a well-planned electric system is the minimizing of maintenance without increasing the capital investment excessively to achieve that objective. Considerations of the economics of motor maintenance as affected by motor voltage fall into two general classifications, namely:



MOTOR FRAME DATA

H.P.	3600 RPM		1800 RPM		1200 RPM	
	2300V	440V	2300V	440V	2300V	440V
3		224		225		254
5		225		254		284
7½		254		284		324
10		284		324		326
15		324		326		364
20		326		364		365
25		3655		365		404
30		4045		404		405
40		4055	445	405	5040	444
50		4445	5045	4449	5040	445
60	5045	4455	5047	4455	505	5040
75	5049	5045	5055	5045	6325	505
100	5055	5055	63255	5055	63255	63253
125	63255	63255	63255	63255	63265	63265
150	63265	63265	63265	63265	63335	63335
200	63285	63285	63285	63285	63355	63355

FIGURE 20

a) Considerations pertaining to the physical equipment, such as size, weight, accessibility, etc.

b) Considerations pertaining to the degree of skill involved, such as the higher degree of skill required to work 2300 volts "hot" as compared to 440 volts; degree of supervision required, etc.

Maintenance Considerations of the Physical Equipment

Motors

A high-voltage compared with a low-voltage motor will, as a rule, require more maintenance if compared over a long period of time. This is in part due to design limitations which necessitates more winding turns of smaller wire, and more turn-to-ground and turn-to-turn insulation per unit voltage on 2300 and 4000-volt motors than on equivalent 440-volt motors. The more complex construction of the high voltage motor coils is reflected in the cost of rewinds when compared with 440-volt motors. Rewind costs are shown in Figures 16, 17, and 18. It is of interest to point out at this time that lightning, which is responsible for many rewinds, is much less severe on 440-volt equipment than on higher voltages due to the impedance of the 440-volt transformer bank.

While not of too great significance, the weights of 440-volt motors are generally less than 2300-volt motors and as a result can be handled with greater ease. This is illustrated in Figures 19 and 20. Various other physical characteristics such as bearings, lubrication, ventilation, etc., are alike for motors of different voltages but comparable size.

Motor Controllers

The complexity of controllers increases generally as the voltage is increased. Twenty-three hundred and higher voltage controllers require potential transformers for control and often complicated devices and circuits for protection. Lower voltage motor controllers usually take control circuits directly from the motor service circuit and are protected with simple series devices.

The 2300 and 4000-volt motor controllers are generally oil immersed with the attendant fire hazards and oil maintenance problems. In the case of 440-volt motor controllers, air-break equipment is available and generally preferred where contact corrosion is not a limiting factor. The use of air-break equipment contributes to longer contact life and eases maintenance since the controller equipment is generally lighter and cleaner. The total weights of various motor control equipment are shown in Figure 21.

Low voltage motor controllers generally are furnished in a compact integral form which results in greater accessibility and an over-all simpler installation. The 2300 and 4000-volt motor controllers generally consist of two separate items of equipment which require considerable interconnections and also presents a complicated arrangement for servicing. The weight of the high voltage controller is considerable and often requires hoisting equipment.

Availability of Equipment as a Function of Voltage

With few exceptions 440-volt motors and equipment are more easily obtainable than 2300 or 4000-volt equipment. This is important when some equipment being repaired is urgently needed back in service and maintenance time must be minimized. It is also of importance when construction schedules must be met.

All electrical maintenance work divides into classifications, depending on the varying degree of craftsmanship required to perform the work. Generally the performance of the higher degree skills is more costly and, further, fewer personnel qualify to perform such tasks. It is recognized that the degree of personal hazard involved when working various voltages divides into three general groups as follows: a) The 600-volt group, which includes all voltages up to 600 volts; b) the 2400 and 4160-volt group; and c) the voltages 12 kv. and above. The higher the voltage the greater is the degree of personal hazard and in general the higher the degree of skill required to make repairs and installations. And, in addition, closer supervision is required. The conclusions can only be drawn that the extension of repairs to voltages in the 2400-volt range and above are comparatively expensive besides representing a class of work that can only

be entrusted to highly skilled mechanics.

There are many electrical maintenance assignments which must be worked "hot." In this respect, 440 volts can be worked more easily than 2300-volt equipment. More elaborate precautions must be employed with the high voltages to reduce personal hazard which, in turn, entails valuable time.

Summary of Maintenance Considerations

In general the maintenance of 440-volt equipment is more easily performed than for higher-voltage equipment. This is due to the inherent simplicity of the low-voltage motors and equipment. Further, a lesser degree of personal hazard and skill required to extend repairs is involved.

Motor and equipment manufacturers have attempted to build the necessary degree of reliability into all of their equipment. However, appraisals of the degree of reliability required of specific installations must always be made and the choice of equipment be based upon the facts found. Such a case is the choice of double-ended 440-volt outdoor substations; the selection of totally-enclosed motors when open-type motors might possibly suffice; the choice of dust-tight motor controls in lieu of general purpose controls; etc.

Notwithstanding, the continual efforts of the manufacturers to build a similar degree of reliability in high-voltage equipment as compared to low-voltage equipment, it appears that the latter is more reliable for the following reasons:

1) 440-volt motors and motor controllers are simpler and very rugged.
2) 440-volt motors and motor controllers inherently possess a greater degree of freedom from switching, lightning surges and high-capacity shorts.
3) 440-volt motors and motor controllers can in general be more easily serviced and thus encourage more systematic maintenance.

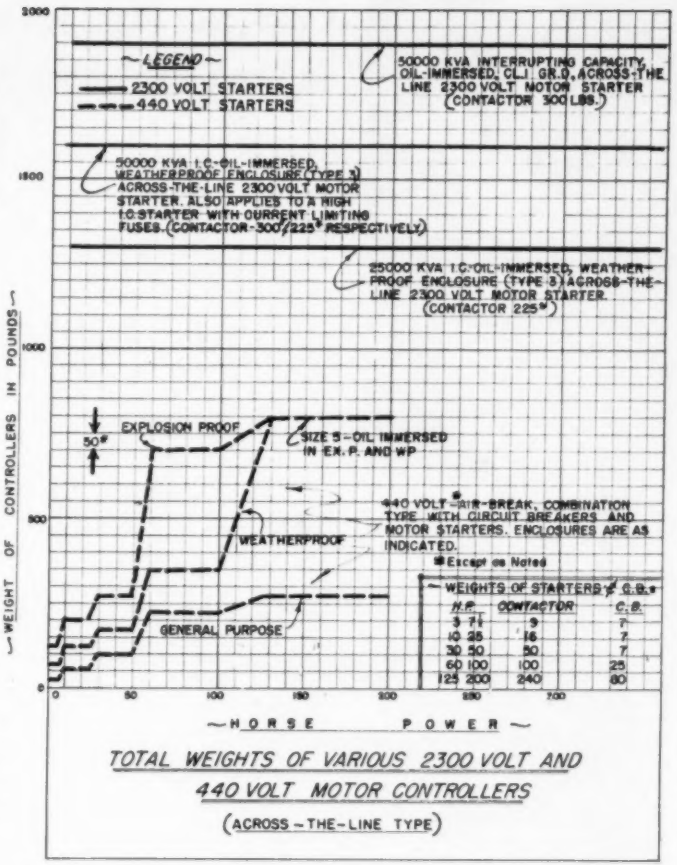

LEGEND
2300 VOLT STARTERS
440 VOLT STARTERS
50000 KVA INTERRUPTING CAPACITY, OIL-IMMERSED, CL. I GR. D, ACROSS-THE-LINE 2300 VOLT MOTOR STARTER (CONTACTOR 300 LBS.)
50000 KVA I.C. OIL-IMMERSED, WEATHERPROOF ENCLOSURE (TYPE 3) ACROSS-THE-LINE 2300 VOLT MOTOR STARTER. ALSO APPLIES TO A HIGH I.C. STARTER WITH CURRENT LIMITING FUSES. (CONTACTOR-300/225* RESPECTIVELY)
25000 KVA I.C. OIL-IMMERSED, WEATHER-PROOF ENCLOSURE (TYPE 3) ACROSS-THE-LINE 2300 VOLT MOTOR STARTER. (CONTACTOR 225*)
WEIGHT OF CONTROLLERS IN POUNDS
2000
1500
1000
500
0
50#
EXPLOSION PROOF
SIZE 5 - OIL IMMERSED IN EX. P. AND WP
440 VOLT AIR-BREAK, COMBINATION TYPE WITH CIRCUIT BREAKERS AND MOTOR STARTERS. ENCLOSURES ARE AS INDICATED.
*Except as Noted
WEATHERPROOF
GENERAL PURPOSE
WEIGHTS OF STARTERS & C.B.s
H.P. CONTACTOR C.B.
3 7½ 9 7
10 25 16 7
30 50 50 7
60 100 100 25
125 200 240 80
0 50 100 150 200 550 700
HORSE POWER
TOTAL WEIGHTS OF VARIOUS 2300 VOLT AND 440 VOLT MOTOR CONTROLLERS
(ACROSS-THE-LINE TYPE)

FIGURE 21

Conclusions

On the basis of the direct and indirect costs of a motor installation as presented in this article, it can be concluded that installations up to and including 100 hp. can be more economically accomplished by using 440 volts. This conclusion is independent of the system transmission voltage used but does presume that 440-volt feeders as well as motor leads are not of excessive length. This assumption agrees with modern practices of unit substation distribution.

Motor installations above 100 hp. can be most economically made by using 2300 or 4000-volt motors and equipment. Since the cost of 2300-volt motors is less than for 4000-volt motors, the use of 2300 volts is favored generally for motor installations above 100 hp. This assertion is based upon the following premises:

1) That distribution circuits do not exceed 4000 feet.
2) That circuit loadings are not permitted to exceed 1500 kva.
3) That 13.8-kv. distribution is utilized and service extensions to large blocks of motor loads which are compact geographically are contemplated.
4) That the number of motors above 100 hp. constitutes a large proportion of the connected motor load.

The use of 4160-volt distribution systems goes hand in hand with the use of 2400-volt. Its use in preference to 2400 volts is associated with the savings realized by improved system operation when this consideration outweighs the economic advantage obtained by using the lower cost 2300-volt motors and equipment. Also as pointed out, 4160-volt distribution compares more favorably with 2400 volts, all other factors as noted being considered, when plant loads approach approximately 7500 kva. At this loading 2400-volt bus construction becomes costly both as regards physical space requirements and increased equipment cost. In this connection, an existing 2400-volt system can usually be changed over to 4160 volts at comparatively small cost. Twenty-four hundred volt switchgear has a 5-kv. rating and most large motors can be reconnected to 4160 volts.

Whether 2400 or 4160 volts is most favorable for distribution is so vitally a function of individual plant layout and special requirements that only after careful consideration can definite recommendations be conceived.

Copolymer Plant Is First To Use Cold Rubber Process

The three pictures illustrate a "short cut tour" of the huge Copolymer cold rubber plant at Baton Rouge, La. Giant reactors mix the cold rubber ingredients under a temperature of 41°. Bottom photo at right shows two men peering into one of the Copolymer reactors, from which cold rubber emerges as a milky latex similar in appearance to the fluid extruded from the rubber tree. This milky fluid or latex is next coagulated and washed free of all chemicals, photo above. The rubber is then pressed into blocks, top photo at right, ready for shipment to tire manufacturing plants. The Copolymer plant, operated for the federal government by eight tire companies and Phillips Petroleum Company, commencing May 24 doubled its cold rubber production capacity to 30,000 tons annually.

THE Copolymer Corporation, operator of the government-owned synthetic rubber manufacturing plant at Baton Rouge, La., has converted the entire facilities of the plant over to the production of cold rubber—the most recently developed process for commercial production of synthetic rubber. A celebration, commemorating completion of work and capacity production of the plant was held May 24.

More than 5 million pounds per month is produced by the plant. According to A. L. Freedlander, president of Copolymer, cold rubber will go far toward making this hemisphere independent of foreign rubber sources, and it has quality possibilities for the future unequalled by any natural source. Cold rubber in tests has proved that "in tires it will give the average motorist at least 30 percent greater mileage than the best grades of natural rubber in tire treads."

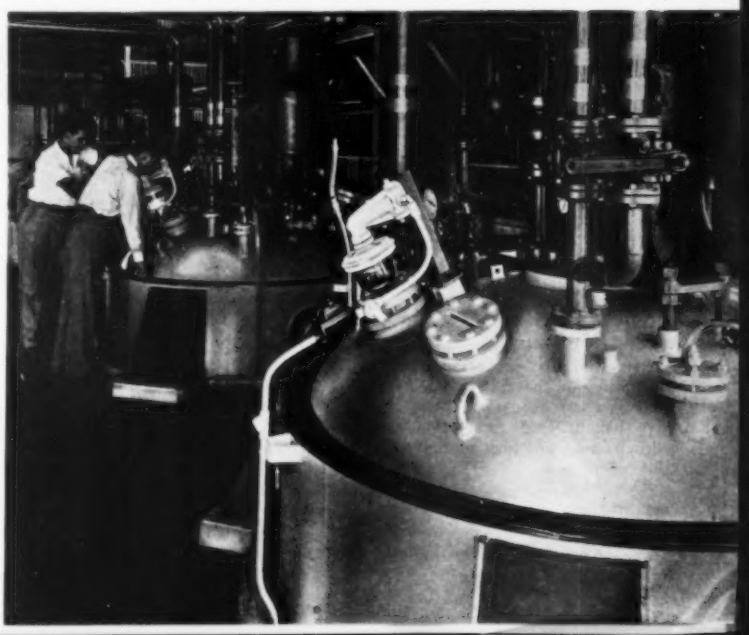
Freedlander said that cold rubber marks the first time in 173 years—or since the discovery of rubber—that the quality of the best natural rubber has been exceeded let alone equalled. Tires with cold rubber tread will cost no more than tires of natural rubber, he said.

Colonel C. M. Hulings, operating vice president of Copolymer, paid tribute to Phillips Petroleum Company for its outstanding research and development work in the cold rubber program. In relating the history of the development of cold rubber Colonel Hulings said Copolymer began pilot plant work for cold rubber to substantiate results obtained by Phillips in early 1947. Test tires were built from the rubber and the results caused the corporation to request permission from Rubber Reserve to convert one half of the plant to the production of cold rubber. This program was completed in February, 1948. Since that time the plant has produced 33 million pounds of cold rubber and production costs have been reduced to that of regular synthetic rubber. The "Custom Recipe" developed by Phillips has been of great value in operation of the process, he said.

Dr. W. B. Reynolds, supervisor of synthetic rubber development of Phillips Petroleum Company, pointed out that cold rubber had been known by the Germans as far back as World War I, but the method was too slow for commercial production. One of the factors responsible for the final rapid development of cold rubber was the development of a new process introduced at the University of Cincinnati. Chemists at the University of Minnesota modified this process, which was studied by Phillips and then further modified for large scale production.

The new process operates at 41° F. compared with the reaction temperature of 122° F. used for GR-S, largely because that temperature was required for the 15-18 hour reaction for the first government plants of which the Copolymer plant was the first to be opened in 1943. Dr. Reynolds believes it entirely possible that synthetic rubber will someday make the rubber tree obsolete.

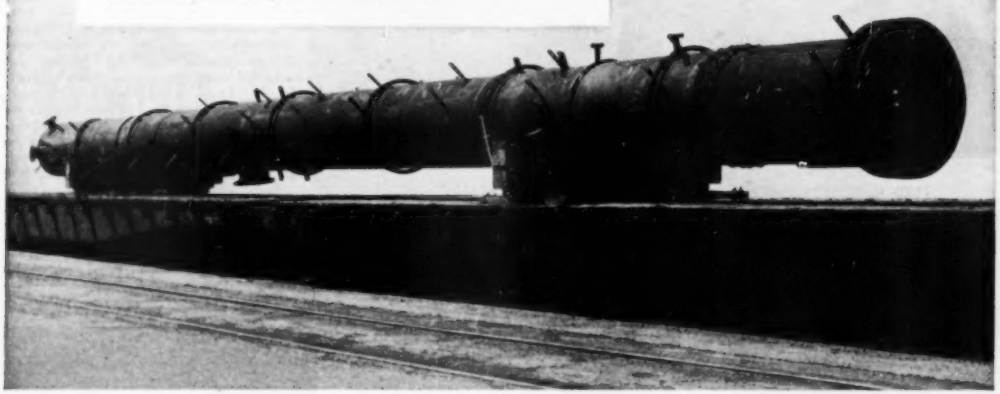
Companies operating the Baton Rouge plant as Copolymer Corporation are Armstrong Rubber Company, Dayton Rubber Company, Gates Rubber Company, Inland Rubber Corporation, Lake Shore Tire & Rubber Company, Lee Rubber & Tire Company, Mansfield Tire & Rubber Company, and Sears, Roebuck & Company.



ANOTHER WHALE OF A JOB WELL DONE

Fabricated from, and welded with, HERCULOY!

Pre-job view of Herculoy fractionating column. Overall length of this giant vessel is 88 ft. Outside diameter is 42". Shell thickness, ⅛" at bottom, becomes progressively thinner, until at the top it is only ¼" thick. Fabricated for the petroleum industry by the John Nooter Boiler Works Company, St. Louis, Missouri. Job has now been completed. See story below.



WHEN the John Nooter Boiler Works Company received an order for the construction and installation of an 88 ft.-high, fractionating column, Nooter engineers tackled another big job.

Into this huge vessel went not only Nooter precision workmanship, but the right metal.

That metal had to have the strength of mild steel and the corrosion resistance of copper. In addition, it had to be the right metal for welding that would hold fast under stresses and strains of operating conditions.

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Herculoy, you see, is not only fabricated into pressure vessels of almost any size by the conventional methods, but it can be soundly welded.

This job required 220 lineal feet of welded seam on the shell alone. The seam was manually welded with heliarc. The welds were all X-rayed, and it has been estimated that about 200 X-rays were made on this one vessel. The X-rays showed perfect welds except at two places, where it was necessary to clip out 1" sections of the weld to be done over.

The entire vessel was stress relieved at 600° F. in a 60 ft. furnace requiring annealing in two sections. Although the specifications permitted a curvature of ¾" from bottom to top, the completed vessel was out of plumb only ⅛".

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REFINER AUTHORS and Other Personalities

Information, formal and otherwise, about the men who write for PETROLEUM REFINER as well as others prominent in the industry.

FRED H. POETTMANN

B. J. MAYLAND

Teaching Extension Courses Results in Most Informative Article

FROM the Phillips Petroleum Company research department comes Report No. 736-49R, which PETROLEUM REFINER presents as "Equilibrium Constants for High Boiling Hydrocarbon Fractions of Varying Characterization Factors," the article beginning on page 101 of this issue by Drs. Poettmann and Mayland. Readers may recall that Poettmann collaborated with R. B. Rice in the December, 1947, issue of PR, on "Nomographs for Vapor-Liquid Equilibrium Calculations."

Dr. Fred H. Poettmann is known as just plain Fred around the department in Bartlesville. He was born in 1919 in Cleveland, Ohio, began his formal education in 1938 at the Case Institute of Technology, and was graduated in 1942 in chemical engineering. From 1943 to 1946 he attended the University of Michigan, where he received his masters and Sc.D. in chemical engineering. In January, 1946, he joined the Phillips Petroleum Company research staff where he has been engaged in research on problems connected with reservoir engineering. He has been teaching graduate courses, along with Dr. Mayland, in chemical engineering through the Oklahoma A. & M. Extension Service in Bartlesvilles for the past two years. As a matter of fact, the article is a direct result of their cooperation in these courses.

A registered professional engineer in Oklahoma, Poettmann is a member of ACS, AIME, AIChE, and AAAS. Also, he is a member of Sigma Xi, Tau Beta Pi, and Phi Kappa Phi. He is secretary-treasurer of the Oklahoma Section of the AIChE.

A hobby of photography holds his extra-curricular interest.

Dr. Bertrand J. Mayland, a senior chemical engineer in the research department, joined Phillips in 1943. His work concerns problems associated with process engineering, process evaluation, and pilot plant developments.

Mayland was born in 1916 at Racine, Wis., attended the University of Wisconsin from 1936 to 1940 and was graduated with a B.S. in chemical engineering. He then attended the University of Illinois for three years majoring in chemical engineering and received his master's and Ph.D. degrees.

He has been teaching evening courses for Oklahoma A. & M. since 1947 in chemical engineering, which has included separation, thermodynamics, fluid flow, heat transfer, and mathematics. He is a member of Tau Beta Pi, Sigma Xi, Phi Lambda Upsilon, ACS, and AIChE.

Dr. and Mrs. Mayland are the proud parents of three daughters, ages 6 years, 3 years, and 3 months, respectively. Mayland's hobby of electronics and amateur radio, get most of their attention after the youngsters have been tucked in bed.

V. A. Assistant Is PR Contributor

DR. EUGENE F. MURPHY, assistant director for research, prosthetic and sensory aids service, Veterans Administration, 252 Seventh Avenue, New York, who prepared the article, "Natural Frequencies of Compressor and Engine Manifolds" became interested in predicting natural frequencies of vibration of compressor and engine intake and discharge piping systems during his association with the engineering department of Ingersoll-Rand Company (1936-39). The article, which begins on page 151 of this issue of PR, is a discussion of the results of his studies on the subject.

Dr. Murphy has developed a method for predicting the natural frequencies of proposed compressor piping systems. His predicted frequencies are frequently within one percent of the experimentally determined values.

A native of Syracuse, N. Y., Murphy was graduated from Cornell University in 1935 with a degree in mechanical en-

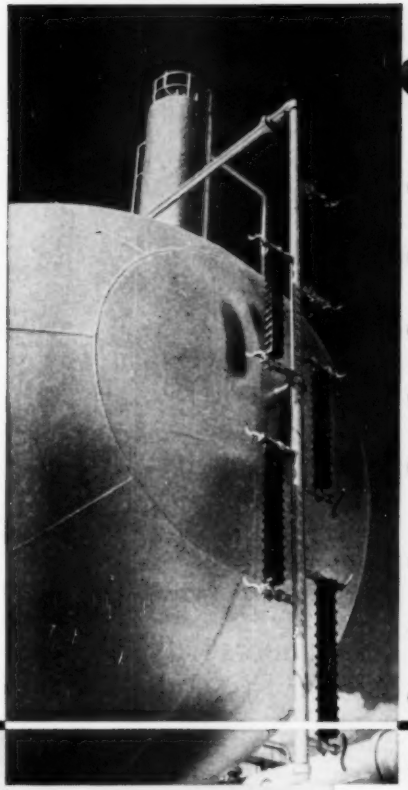
DR. EUGENE F. MURPHY

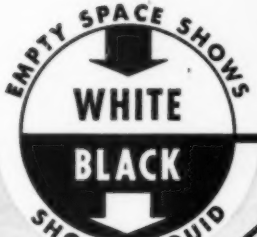
WHEN YOU MUST

BE SURE

OF THE

LIQUID LEVEL





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gineering. He took postgraduate work at Syracuse University for his M.M.E. in 1937, then did advance study at Illinois Institute of Technology in Chicago, where he received his Ph.D. Dr. Murphy was formerly assistant professor of mechanical engineering at the University of California. This article is based upon parts of the thesis for Ph.D. in mechanical engineering at Illinois Institute of Technology.

Safety Engineer Writes on Mixing Leaded Gasolines

L. R. FLECK, safety engineer in the New York office of the Ethyl Corporation, presents the article beginning on page 139 of this issue, "Mixing Leaded Gasolines." This article contains a discussion of the most-up-to-date safety practices in this connection.

Fleck is a Pennsylvanian, born in Altoona. He was graduated from the University of Pittsburgh in 1932 with a B.S. in mechanical engineering. Before joining Ethyl Corporation in 1937, he had been engaged in research and development with May Oil Burner Corporation in Baltimore for three years.

From field engineer in the Baltimore district, Fleck went to Tulsa as a safety engineer for Ethyl. He became senior safety engineer in 1940. He served in the army for five years, attaining rank of major, and participating in a number of the European campaigns.

He returned to the Tulsa office in 1946, and shortly thereafter was transferred to the safety department in the New York offices. He is a member of the American Industrial Hygiene Association.

L. R. FLECK

R. R. MACCARY

R. F. FEY

Engineers with Similar Backgrounds Offer First Refiner Contribution

SIMILAR hobbies and similar professions make R. R. Maccary and R. F. Fey fine co-authors for "Minimum Thickness of Cylindrical Shells for Steel Tanks and Pressure Vessels," starting on page 136 of this issue of PETROLEUM REFINER. The country life holds a charm for both men. Maccary defines his hobbies as earth moving, crop rotation and road maintenance. Fey sticks to gardening, horticulture and poultry raising.

Recently the two authors organized Process Industries Engineers, Inc., in Pittsburgh, to serve the processing industries in applying standard and developing and building special equipment. President of the concern is Maccary while Fey is chief engineer and secretary-treasurer.

Early in his career **Maccary** accomplished the transition from a designer of interior decorations to the geometry and design of plant equipment, leaving his wife to handle the decoration of his home without his assistance. After receiving his bachelor of mechanical engineering degree from the Cooper Union Institute of Technology and doing graduate work at New York University, he joined Griscom-Russell Company, designing conventional and unconventional heat exchange apparatus. Moving to The M. W. Kellogg Company, Maccary specialized in the developmental design of refining process equipment. For his work in the development and supervision of the design of the processing equipment for the Oak Ridge diffusion plant of the atomic bomb with Kellex Corporation, he received the "Atomic Project Gold Key" and credit of several patents of original equipment design assigned to the U. S. Army. After the war he was director of engineering of the process equipment division of H. K. Porter Company.

Fey was graduated from the Carnegie Institute of Technology with a bachelor or science degree in civil engineering and then did graduate work at the same university. Employed for many years by Pittsburgh Des Moines Steel Company, he designed and estimated steel plate structures for units ranging from elevated storage tanks to wind tunnels. Two years he won the "Lincoln Electric Welding Contest" with papers on new developments in welded steel plate structures. During the war Fey was project engineer on the development, design and construction for three of the supersonic wind tunnels for testing projectiles and rockets built in the United States. His activities continued in the same general field as chief engineer of the process equipment and pump division of H. K. Porter Company.

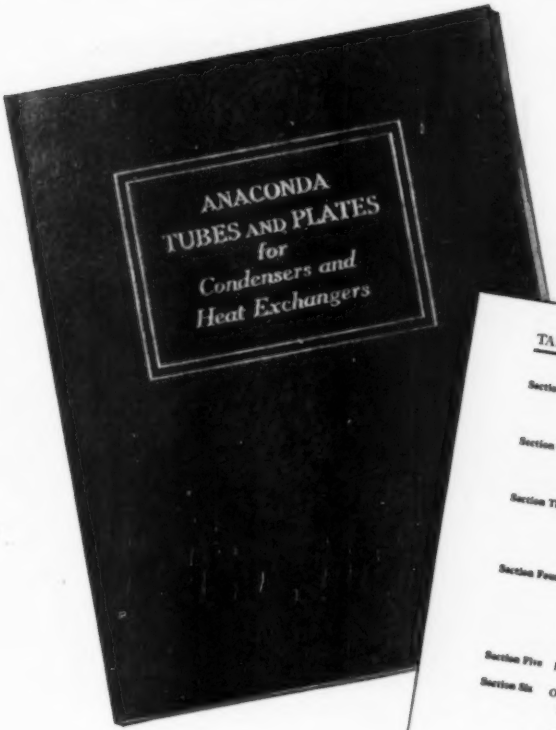
Further articles from these two engineers are in the making.

Learned Named Director

Stanley Learned last month was elected a director of Phillips Petroleum Company, Bartlesville, Okla., to fill a vacancy created by the death of H. A. Lemp of St. Louis. He also goes on the company's executive committee vice Frank Phillips, retired.

Ball To Get Medal

Max W. Ball, former head of the Oil and Gas Division of the Department of the Interior, will be awarded a Distinguished Service Gold Medal in recognition of 15 years department service.



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Maintenance and Operation—

HOW TO DO IT

HOW—

Shop-Made Tools Aid Repair Work

THIS view, typical in a gasoline plant machine shop, shows two items of equipment that were constructed in the shop for use in repair work—a press and a portable work bench.

The press (left) is made with standard structural channels bolted together. The position of the anvil plate can be changed to accomodate the work by removing pins through the anvil and the upright beams of the press, moving the anvil to the new position and replacing the pins.

At the right is a portable work bench for use in the process area of the plant. Top of the bench is covered with steel plate. A heavy vise is mounted on the bench and drawers and compartments provided beneath the top for tools and small parts. The work bench is also used to move heavy valves and similar equipment from points in the plant, inaccessible to trucks, into the shop.

Supply bins in the rear of the shop are clearly labeled to avoid confusion and hunting for parts.

HOW—

Compressor Engine Base Is Cleaned

TO CLEAN cuttings, oil film, gum, and dirt from the base of large engines, such as compressor engines, the operators in one gasoline plant employ kerosine, compressed air, and a nozzle. Cleaning work is done through the inspection plates of the base.

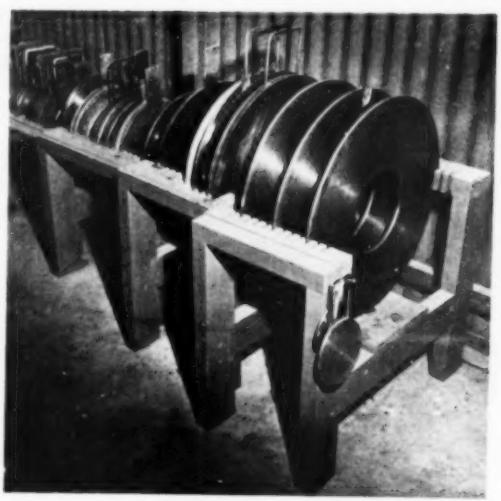
The nozzle used is a paint spray gun with several changes made to adapt it to the job of engine cleaning. The atomizing spray nozzle was removed from the head of the gun and replaced with a ¼-inch tube about 14 inches long. One end is flattened so that the kerosine-air mixture emerges through a narrow slot with sufficient force to wash dirt and grease from the engine without atomizing the kerosine and creating a safety hazard. The container, normally a part of the gun was replaced with a hose connecting the gun to a large container for the kerosine.

When a compressor is down and the lubricating oil has been drained from the base, the inspection plates are removed and the base thoroughly cleaned with the nozzle gun. According to the operators, the clean engine gets better lubrication, which reduces wear and lengthens the useful life of the lubricating oil.

HOW TO—

Store Orifice Plates

ORIFICE plates can be stored in the racks shown in the photograph without damage to the edges of the orifice. In addition, any plate wanted can be taken from the rack without removing the others. The rack was built by the personnel of a gasoline plant in East Texas to eliminate storing the plates in drawers. This practice had resulted in the outer edge of the plate being slid into the drawer damaging the inner edges of the orifice plate already in storage. Polishing or machining was sometimes required to restore the edges of the orifice.



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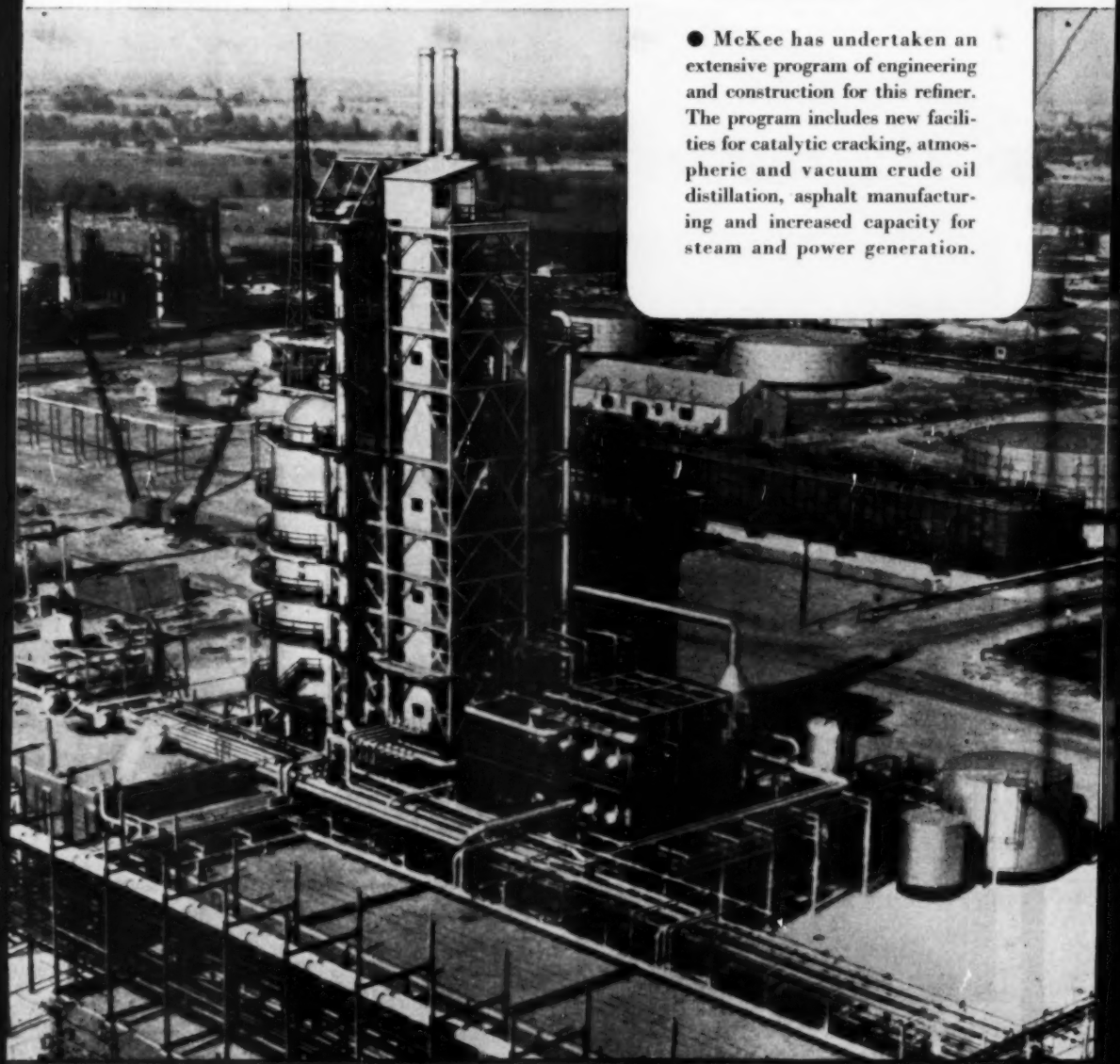

● McKee has undertaken an extensive program of engineering and construction for this refiner. The program includes new facilities for catalytic cracking, atmospheric and vacuum crude oil distillation, asphalt manufacturing and increased capacity for steam and power generation.

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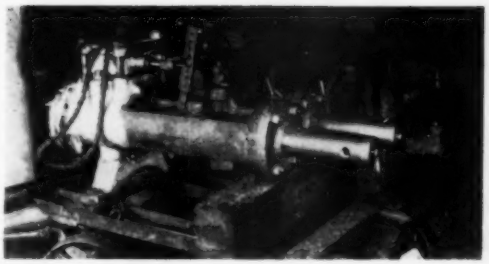
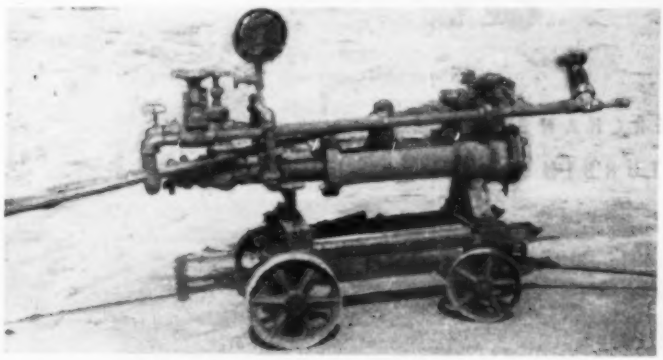
HOW TO—

Convert Duplex Steam Pump Into High Pressure Ram Pump



IN CONVERTING a 6 x 4 x 6 duplex steam pump into a high-pressure ram pump, the fluid end is stripped from the frame to make room for the high-pressure cylinders. New rod parts are installed and steel billets are cut to the required length for the new cylinders. These are bored to the diameter for the rods The rods form the plungers which have been ground to a fit that does not require rings or packing.

The new cylinders are threaded at the outer end for pipe connections, and a hole bored and threaded in the side for the intake port. Heavy steel flanges attach the cylinders to the frame of the old pump. These are welded in place while the cylinders are supported in a jig to obtain correct alignment.



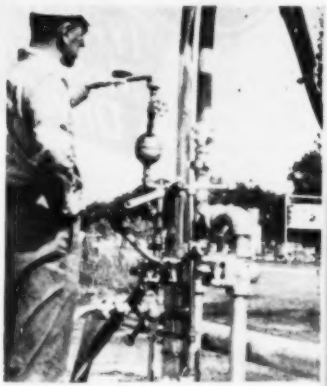
Because the intake is on the side and the discharge through the end, the pump is only a single acting duplex, making it necessary to adjust the valve slides in the steam end to compensate for different operation than when set for duplex double acting. Heavy forged steel check valves are installed in the suction and discharge piping to operate as fluid valves. Any type manifold may be arranged for the purpose desired. Plunger packing is used by adapting the original stuffing box and packing gland.

HOW TO—

Odorize L-P Gas

WHEN small quantities of L-P gas are to be loaded for truck transportation, the problem of odorizing the material is sometimes difficult to handle. The method shown in the photograph in use at a truck loading rack accomplishes the odorizing operation quickly and easily. It permits injection of the correct amount of odorant and eliminates waste.

The lubricator is made from the round ends of two bull plugs welded together

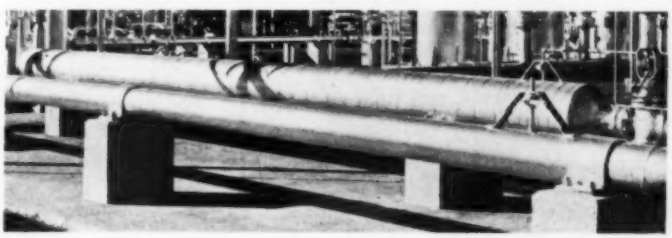


to form a small spherical tank about two inches in diameter. Quarter-inch pipe is welded or screwed into fittings on opposite sides of the tank and a shutoff valve and pipe reducer (funnel) is connected to the pipe on one side. The lower line is connected through a second valve to the truck loading line riser with a fitting inserted into the line to provide a fine stream of odorant to mix with the L-P gas stream as it flows past the connection.

To load the lubricator, the bottom valve is closed, and the top valve opened to admit the odorant poured into the funnel. Then the top valve is closed. When the L-P gas is flowing through the line, the lower valve is opened to permit the odorant to enter the loading line and mix with the gas stream.

HOW TO—

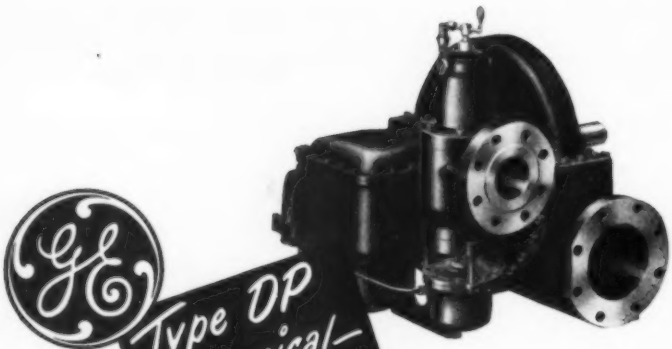
Prevent Hydrates



QUITE often the inlet gas to a cycling or gasoline plant is at such high pressure that it must be reduced before contacting with lean oil in the absorbers. The cooling effect produced by expansion of the gas during pressure reduction may be responsible for the formation of hydrates, especially if the gas stream contains any appreciable quantities of water vapor and hydrocarbon liquids.

This problem can be solved in several ways. The method employed in one plant, as shown in the photograph, of preventing such hydrate formation when inlet gas pressure is reduced is by utilization of the heat in the plant exhaust steam.

A section of the inlet line is jacketed with a line of larger diameter, the ends of which are swaged and welded to the gas line. Steam is admitted at the downstream end of the jacket and heats the entire area of the inlet line wherein hydrates tend to form. To conserve heat, the jacketing line was fully insulated.

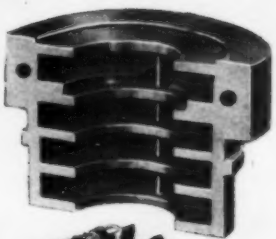


GE Type DP Mechanical-Drive Turbine

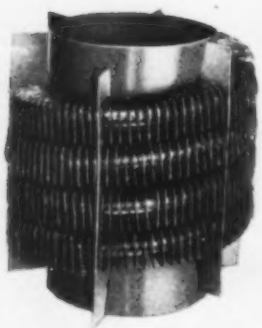
SAVE WITH

THESE PARTS INTERCHANGEABLE
ON ALL TYPE DP TURBINES!...

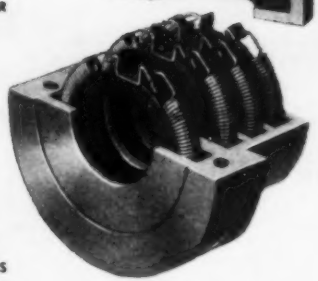
SHAFT, MONEL-SPRAYED AT PACKINGS



NONSPARKING OVER-SPEED GOVERNOR



HIGH-CAPACITY OIL COOLER



DOUBLE-SEAL CARBON PACKINGS

STANDARDIZATION!

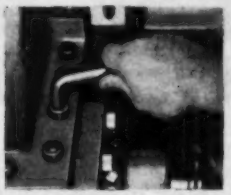
IF you operate a number of mechanical-drive turbines, interchangeability of parts can be a mighty potent factor in saving time and trouble when replacements must be made. With the General Electric Type DP you can interchange all the important parts shown—and many more—regardless of turbine size. Also, one low-cost standard spare parts kit serves any DP turbine.

Standardization saves your time when installing or relocating DP turbines too. Common shaft height, regardless of wheel size, permits you to use a standard mounting height. Since all shafts are identical, couplings can be standardized as well.

The new Type DP is not a "standard turbine" for a narrow range of ratings only, but a standardized line, in ratings from 10 to as much as 1200 hp, speeds from 1000 to 5000 rpm. Thus, if your turbine drives fall within this wide range, you can save money—time—and trouble—by standardizing on the Type DP. For full information get in touch with your G-E representative. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

TURBINE OIL PUMP

SOLID-BACKED BEARINGS

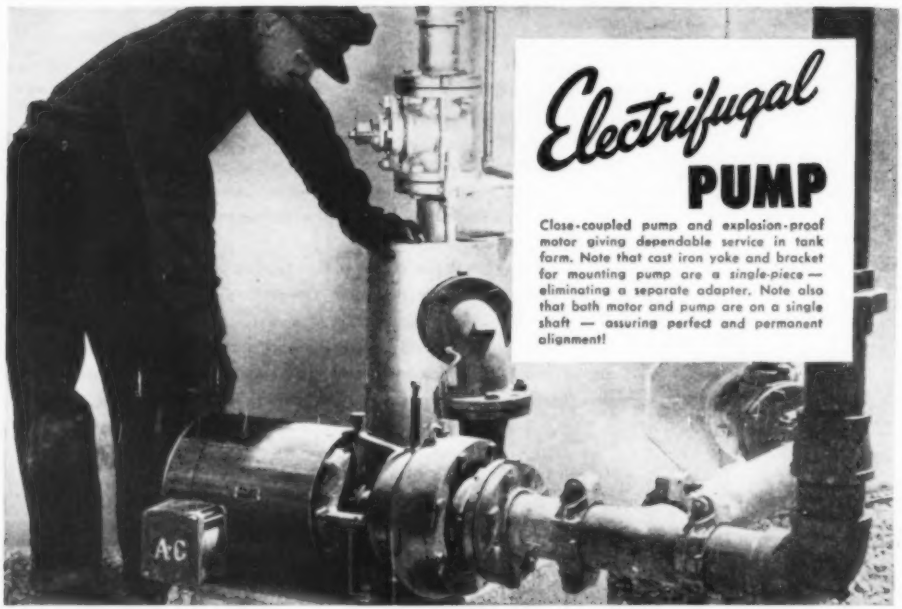


SOCKET-HEAD CAP SCREWS

LOW-COST STANDARD SPARE PARTS KIT

GENERAL ELECTRIC

How Unit Construction Cuts Petroleum Pumping Costs


Electrifugal
PUMP
Close-coupled pump and explosion-proof motor giving dependable service in tank farm. Note that cast iron yoke and bracket for mounting pump are a single-piece — eliminating a separate adapter. Note also that both motor and pump are on a single shaft — assuring perfect and permanent alignment!
A-C

SAVES YOU MONEY THESE 3 WAYS:

- **In Installation** — Installation is easier, quicker — pump comes ready to run. No alignment problems. No extra parts. Easy to handle. Requires small space.
- **In Operation** — Pump and motor designed together to give high efficiency. Every unit tested and guaranteed.
- **In Maintenance** — Cannot get out of alignment. Has fewer parts and fewer machined fits. Bronze wearing ring protects casing from wear and is easily replaced when required.

The *Electrifugal* pump, ranging from 10 to 1600 gpm with heads to 525 feet, is just one of many types of pumps built by Allis-Chalmers for industrial service. You can depend on the recommendations of the A-C pump application engineer to give you dependable service at lowest cost. For information, see your Allis-Chalmers Authorized Dealer or Sales Office or write for Bulletin 52B6059E. A-2774

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THE MONTH in the INDUSTRY

* * *

Expansion, Modernization In 1949 to Be $2.1 Billion

Capital expenditures by the U. S. petroleum industry in 1949, for expansion and modernization, will total about $2,146,206,000, a decrease of 8.9 percent from the peak of $2,355,033,000 reached in 1948, according to an API survey. The 1949 total will be equivalent to $53 for each of the 40 million cars, trucks, and buses in the country. Major part of the capital will come out of oil company earnings.

Of the projected 1949 capital expenditures, $1,134,784,000 (52.9 percent) will go into the production division, $524,797,000 (24.4 percent) for refining, $201,619,000 (9.4 percent) for transportation, $232,145,000 (10.8 percent) for marketing, and $53,461,000 (2.5 percent) for other facilities.

The above percentages of the total for production and marketing are slightly higher than in 1948, while those for refining, transportation, and miscellaneous are slightly lower. The total capital expenditures of $2,355,033,000 in 1948 included $1,223,320,000 (51.9 percent) for production, $588,012,000 (25.0 percent) for refining, $264,273,000 (11.2 percent) for transportation, $209,078,000 (8.9 percent) for marketing, and $70,350,000 (3.0 percent) for other facilities.

In 1947 the industry invested $1,878,147,000 in new facilities and rehabilitation. For the three years, 1947, 1948, and 1949, the total will amount to $6,379,386,000. Of this, the production division will account for a little more than 50 percent, with investment of $3,255,489,000.

Dorwin Elected Chairman

Oscar John Dorwin, general counsel of The Texas Company, has been elected chairman of the API American Petroleum Industries Committee. He succeeds Edwin S. Hall, Esso Standard vice president, who retired from the post last March.

Calendar of Meetings

JULY 28	National Petroleum Council, Quarterly Meeting, Washington, D.C.
AUG. 15-17	Society of Automotive Engineers, West Coast Meeting, Portland, Ore., Multnomah Hotel.
17-31	United Nations Scientific Conference on Conservation and Utilization of Resources, Lake Success.
SEPT. 7-10	North American Gasoline Tax Conference, Lake Tahoe, Tahoe Tavern.
11-14	American Standards Association, Annual Meeting, New York, Waldorf-Astoria Hotel.
12-16	NACE Short Course on Corrosion, University of Texas, Austin.
12-16	Instrument Society of America, National Conference and Exhibit, St. Louis, Municipal Auditorium.
14-15	American Petroleum Institute, Division of Marketing (Lubrication Committee) Atlantic City, Hotel Traymore.
14-16	National Petroleum Association, Atlantic City, Hotel Traymore.
18-20	American Institute of Chemical Engineers, Montreal, Canada, Mt. Royal Hotel.
SEPT. 19-21	National Butane-Propane Association, St. Louis.
24-28	National Safety Council, Chicago, Morrison Hotel.
28-30	The American Society of Mechanical Engineers, Fall Meeting, Erie.
OCT. 2- 5	American Society of Mechanical Engineers, Petroleum Division, 1949 Petroleum Mechanical Engineering Conference, Oklahoma City, Oklahoma, Biltmore Hotel.
3- 4	National Association of Corrosion Engineers, South Central Region, Dallas, Adolphus Hotel.
OCT. 3- 5	National Lubricating Grease Institute, New Orleans, Hotel Roosevelt.
5- 7	American Institute of Mining and Metallurgical Engineers, Petroleum Division, Fall Meeting, San Antonio, Texas, Plaza Hotel
7	California Natural Gasoline Association, Los Angeles, Ambassador Hotel.
10-14	American Society for Testing Materials, West Coast Meeting, San Francisco, Calif., Fairmont Hotel.
13-14	Texas Mid-Continent Oil and Gas Association, Annual Meeting, Houston, Rice Hotel.
17-20	American Gas Association, Annual Convention, Chicago.
17-21	American Society for Metals, National Metal Congress and Exposition, Public Auditorium, Cleveland, Ohio.
31 to Nov. 4	National Safety Council Congress, Chicago, Morrison Hotel.
NOV. 1- 2	Society of Automotive Engineers, Diesel Engineers, St. Louis, Mo., Chase Hotel.
1- 5	Pacific Chemical Exposition, San Francisco, Civic Auditorium.
3- 4	Society of Automotive Engineers, Fuels and Lubricants, St. Louis, Mo., Chase Hotel.
7-10	American Petroleum Institute, 29th Annual Meeting, Chicago, Stevens Hotel.
7-10	American Institute of Chemical Engineers, Pittsburgh, Hotel William Penn.
27 to Dec. 2	American Society of Mechanical Engineers, Annual Meeting, New York, Hotel Statler.
DEC. 4- 7	American Institute of Chemical Engineers, Annual Meeting, Pittsburgh, Pa., William Penn Hotel.

Buying Power of Industry Down Despite Profits Gain

Combined net income of 30 United States oil companies, comprising nearly two-thirds of the nation's petroleum industry, amounted to only $916 million last year in terms of 1935-1939 purchasing power, although reported earnings of the group totaled $1877 million dollars.

This was one of the conclusions reached by Joseph E. Pogue, vice president of Chase National Bank, and Frederick G. Coqueron, staff associate in the bank's petroleum department, in an annual survey of oil company financing.

The $1877 million net earnings total represented an increase of 54 percent over 1947 and 221 percent over the 1942-46 average.

On the basis of the survey made by the bank, estimated gross investment in property, plants and equipment of the entire U. S. petroleum industry rose from $19,600 million in 1947 to $21,700 million in 1948.

The refining division showed a 19.1 percent distribution for 1948 as compared with 18.4 percent in 1947. Also, investment in the refinery division totaled $4150 million for 1948 as compared with $3600 in 1947.

Wingrove to Paulsboro, Graves Succeeds Him

Byron F. Wingrove, chief process engineer for lubricating oil and wax, Technical Department, at Magnolia Petroleum Company's Beaumont, Texas refinery, has been transferred to the Paulsboro, N. J., refinery of Socony-Vacuum Oil Company, Inc. His new post is assistant to the plant's assistant superintendent in charge of lubricating oil manufacture. Wingrove was graduated from New Mexico Agricultural and Mechanical College in 1935, and came to Magnolia in January, 1938.

Succeeding Wingrove at Beaumont is Francis M. Graves, who has been assistant chief process engineer at Beaumont. Associated with the refinery's Technical Department since 1935, Graves is a graduate in chemical engineering from Texas A. & M. College. L. D. Lynch will assume Graves' former duties, according to a refinery announcement.

Page and Shepard Given New Posts by Standard

Howard W. Page, executive assistant to the president of Standard Oil Company (New Jersey) has been named shareholders' representative for the company's affiliates in the United Kingdom, to take effect in October.

David A. Shepard, who has been shareholders' representative and chair-

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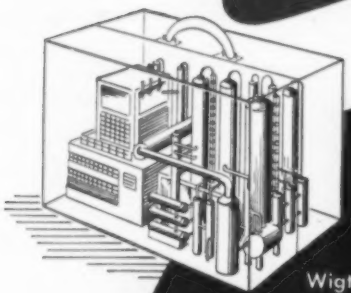
A Complete Service from PLANNING to PRODUCTION



It is a service by Wigton-Abbott Corporation that broadens the definition of plant construction to include creation of the process, designing and installation of equipment, and "delivers" the complete plant, ready for operation.

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Wigton-Abbott Corporation

DESIGNERS...ENGINEERS...CONTRACTORS...PLAINFIELD, NEW JERSEY

man of the board of directors of Anglo-American Oil Company, Limited, will succeed Page as executive assistant to President Eugene Holman. R. A. Carder, of London, a director of Anglo-American, will become board chairman of that company.

Page has had wide experience with the company in foreign and domestic refining and economics for 20 years.

Shepard became associated with the company in 1927 as a research engineer. Before the war he was engaged in foreign marketing activities of affiliated companies in Europe. He was appointed board chairman of Anglo-American in 1945.

Mexico Plans Pipe Lines And Monterrey Refinery

Petroleos Mexicanos, government oil monopoly, plans to expand Mexico's oil production nearly threefold by 1956, meanwhile building pipe lines and refineries to utilize the expanded crude output, General Director Antonio J. M. Bermudez announced last month.

He and Dr. Richard J. Gonzalez, economist for Humble Oil & Refining Company, shared a program on oil resources sponsored by the University of Texas Institute of Latin American studies.

Bermudez said, "We plan to build all the necessary pipe lines and refineries to supply all the future needs of Mexico with products from our own fields. We also intend to build in the near future a refinery at Monterrey which will be suppied by a new pipe line. This refinery, which would have 25,000 to 30,000-barrel daily capacity, will take care of the needs for petroleum products in northern Mexico, and should necessity arise be ready for export to the U. S. across the border line."

Shell Gas Plant Contract Is Awarded to Fluor

Contract for construction of Shell Oil Company, Ltd.'s gasoline plant at Provident City, 75 miles southwest of Houston, has been let to Fluor Corporation, Ltd. Construction has already begun on the gathering system.

The plant, which will have a daily gas-handling capacity of 60 million cubic feet, is expected to be in operation by the summer of 1950.

It will recover approximately 2400 barrels of liquid products daily from the wet gas of Provident field, Hope and Bushy Creek fields to the west, and Englehart field to the east. Residue gas from the plant will be sold to Texas Eastern Transmission Corporation.

Magnolia Lets Contract

Contract for construction of Magnolia Petroleum Company's gas compression plant at Chitwood, Grady County, Okla., has been awarded to Delta Engineering Corporation. The plant, which will have a daily capacity of 25,000 mcf., is scheduled for completion in October, 1949.

The company's pressure maintenance and cycling plant at the same location, which will have a daily capacity of 37,750 million cubic feet of gas, is expected to be completed in December of 1949. Also the Sabine gasoline plant, near Kilgore, Texas, is expected to be completed next month.

La Fortune Is Elected Oklahoma Natural Gas

J. A. La Fortune, executive vice president and director of Warren Petroleum Corporation has been elected a director of the Oklahoma Natural Gas Company.

La Fortune

A past president of the Natural Gasoline Association of America and a member of the American Petroleum Institute's refining committee, La Fortune came to Tulsa in 1919 and occupied a position in the advertising department of the Tulsa World. He later joined the advertising staff of the Mid-Continent Bureau of National Petroleum News. He also served as secretary of the Mid-Continent Oil & Gas Association in 1923, and joined the Warren Petroleum Corporation in 1924 as secretary. In 1929, La Fortune became vice president and later executive vice president. He is director of Warren Petroleum Corporation, vice president and director of Warren Pipe Line, Warren Oil, Warren Maritime and Natural Gasoline Corporation.

Torrance, Calif., Projects Now Nearing Completion

General Petroleum Corporation's three refinery improvement projects costing some $400,000 and designed to conserve natural resources and permit more efficient refinery operations are nearing completion at the company's refinery at Torrance, Calif.

The projects include: a 2-million-gallon pressure storage vessel, called a "noded spheroid," to cut evaporation losses in the shortage of highly volatile natural gasoline; a new cooling tower to make possible the recovery of a higher percentage of the valuable light hydrocarbons which are freed in the refining processes; a chemical treating facility to make possible the recovery of approximately 2000 tons of lead annually, previously lost in processing.

The spheroid is being fabricated and erected by Chicago Bridge and Iron Works Company and is scheduled for completion in July.

The new cooling tower, expected to be completed in August, will recover about 8400 additional gallons of light petroleum fractions, components of high quality gasoline. A total of 11,000 gallons of water will be cooled an average of 28 degrees each minute, releasing 150 million Btu.'s hourly.

The new chemical treating facility, to be completed in the late fall, is designed to reclaim lead from a special chemical called "doctor solution" used to purify gasoline. The operation is to eliminate the wastage of lead, conserving this commodity for other uses.

Socony Plans Four Units

Four Thermofor catalytic cracking units of improved design will be constructed at refineries of Socony-Vacuum Oil Company, Inc., in Trenton, Mich.; Augusta, Kan., and Beaumont Texas.

The units will have a total throughput of 60,000 barrels daily and are expected to be in operation by the end of 1950.

The Beaumont refinery of Magnolia Petroleum Company, an affiliated company, will have two of the new units. They will replace Houdry fixed-bed catalytic cracking units which have been in operation for the past several years. The improved design effects substantial reductions in investment and operating costs and increases flexibility of operation of the TCC unit, Socony officials declared.

THE MONTH...

Foster Wheeler Building England's Large Refinery

The contract for mechanical design, engineering and construction of the large oil refinery in Fawley, England, has been awarded to Foster Wheeler Corporation.

Preliminary work on the new $150 million project for Anglo-American Oil Company, Ltd., British affiliate of Standard Oil Company (New Jersey), already is under way. It is scheduled for completion in about three years.

The nine processing units of the project will consist of a 60,000 barrels per stream day two-stage crude distillation unit; a 50,000 barrels per stream day crude distillation unit; a Fluid catalytic cracking unit; a catalytic cracking and crude gas compression unit; light ends unit; three sweetening units for crude and catalytic cracking naphthas; and an Edeleanu treating unit.

The refinery will have a capacity of 110,000 barrels per day, and will manufacture gasoline, kerosine, gas and diesel oils, heavy residual fuel oils, asphalts, and other products.

With the exception of tankage, marine facilities, and administration and laboratory buildings, Foster Wheeler also will erect all off-site facilities, including a complete steam plant.

Phillips Chemical Doubles Cactus Ammonia Plant

Phillips Chemical Company, a subsidiary of Phillips Petroleum Company, is doubling the production capacity—from 70,000 to 140,000 tons annually—of its Cactus anhydrous ammonia plant near Etter, Texas, with the additional facilities expected to be ready for operation within the next two months.

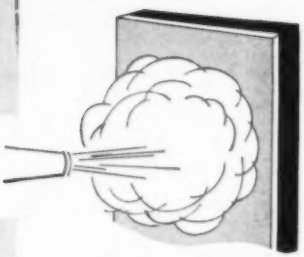
The Cactus plant supplies anhydrous ammonia to Phillips Chemical Company's ammonium sulfate fertilizer manufacturing plant at Port Adams near Houston.

Other facilities are being installed adjacent to the ammonia plant for the production of nitric acid to be used in making ammonium nitrate fertilizer.

The designs are nearing completion and materials are being received for the construction of an ammonium nitrate fertilizer plant to be located in the vicinity of Etter. This plant is expected to be in operation by the latter part of 1949 and will have a production capacity of approximately 100,000 tons of solid ammonium nitrate a year. The plant

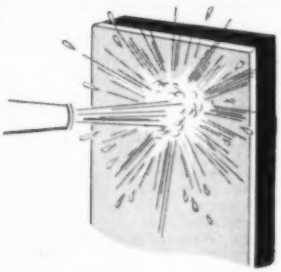
FIRST

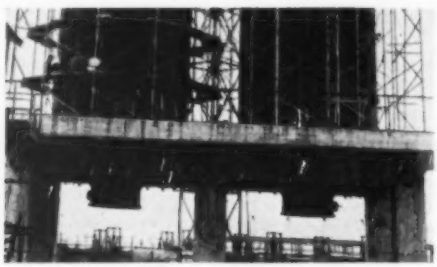
350° STEAM



THEN

60° WATER AT 1500 LBS.





Stainless-Clad Steel decoking tower of Cities Service Oil Company, East Chicago, Indiana, built by Chicago Bridge & Iron Company, Chicago, Ill.

"There has to be a bond to take that punishment"

A materials engineer for an oil refining company was telling why he insisted on a Lukens Clad Steel, with its permanent bond between cladding and backing plate, for their decoking tower.

"Even under those severe conditions, there will be no separation of the metals. We get protection of the equipment and our products from the clad surface, and the bond prevents corrosive materials from creeping in to attack the base metal."

You get this permanence of bond and uniformity of cladding in all Lukens Clad Steels—Nickel-Clad, Stainless-Clad, Inconel-Clad and Monel-Clad. Thus you can obtain the benefits of these *solid* corrosion-resistant metals with the economies possible with *clad* steels.

Lukens makes clad steel plate as wide as 178 inches, or as thick as 6 inches—all in the extra-smooth sodium hydride finish. Applications in the Petroleum Industry are described in Bulletin 461. For a copy, write Lukens Steel Company, 404 Lukens Bldg., Coatesville, Pennsylvania.

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Nickel-Clad Stainless-Clad
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SOLID METAL ADVANTAGES WITH CLAD STEEL ECONOMY

will be equipped to produce large quantities of ammonium nitrate solutions. The Cactus plant will also supply the ammonium nitrate plant with anhydrous ammonia.

Royal Dutch-Shell Plants Increase Output

World operations of the Royal Dutch-Shell group were stepped up last year in comparison with 1947 figures. According to the annual report, the Pernis refinery in the Netherlands processed about 12 million barrels, nearly 30 percent of which came from the Schoonebeek field. An additional unit, completed last September to the Pernis refinery, enabled this plant to boost runs about 40 percent above those of 1947. The refinery in Heysham, England, processed almost 7 million barrels last year, while in Spezia, Italy, the refinery operated at capacity through 1948.

At Suez, the refinery processed 12,300,000 barrels compared with 8,400,000 barrels in the prior year. In North Borneo the Lutong refinery ran about 12 million barrels. At Pladjoe, Indonesia, the refinery which is nearly completely rehabilitated, processed 18 million barrels. Of the boosted oil production in Borneo, about 2,900,000 barrels were processed at the Balik Paper refinery. In North Sumatra, the Pangkalan Brandan refinery remained inaccessible and there were indications that it is badly damaged.

Shell's refinery in Trinidad had total runs of about 8,500,000 barrels. Although the company's refinery on the Paraguana Peninsula of Venezuela is not yet completed, it is now able to process about 50,000 barrels daily.

Royal Dutch Petroleum Company, in a recent statement for the Royal Dutch-Shell Group, sees room for world expansion of oil use as "very great if the interests of a wide range of potential consumers are to be met."

The company points out that ECA countries foresee aggregate petroleum consumption in 1953 about 33 percent above present level. It also says that market requirements in Africa, the Far East, and South America "are likely to grow at least as rapidly."

Komarewsky to Speak

Dr. V. I Komarewsky, professor of chemical engineering and director of the Catalysis Laboratory at Illinois Institute of Technology, will speak before the Danish Chemical Society in Copenhagen in September on the "Catayltic Reaction of Hydrocarbons."

Dr. Komarewsky is an alumnus of Moscow university and has been a staff member of the Kaiser Wilhelm Institute of Biochemistry in Berlin and the Moscow Academy of Mines. He was a lecturer at Northwestern from 1932 to 1934 and joined the staff of Illinois Tech in 1936.

Campbell Is Copy Chief

Don Campbell has been appointed copy chief in the public relations department of Standard Oil Company (Indiana), Chicago, Conger Reynolds, public-relations director, has announced. Campbell previously was public-relations assistant to the vice president, American Locomotive Company, Schenectady, New York.

British Officials to Brief Oil Plans at ECA Meeting

ECA-British oil talks have been scheduled for early July, with ECA reportedly aiming for a showdown on whether Britain means to go ahead with crude production and refinery expansion programs which the Marshall Plan agency regards as unrealistic and overly ambitious.

Representing Britain will be Keith Scott, the representative of Victor Butler, Under-secretary of the Ministry of Fuel and Power. Will Dodge, ECA petroleum representative in Europe, has been handling negotiations with the organization for European Economic Co-operation.

Texaco Completes Unit

The Texas Company has completed its new one-story warehouse at its Eagle Point near Camden, N. J. Also constructed were two concrete platforms, a receiving room, gravity-type roof ventilators, steel sash, plumbing, heating and electrical installations, and offices.

THE MONTH . . .

Carthage Lets Contract

Carthage Hydrocol, Inc. has awarded the contract for construction of its $1800 million gas pipe line to H. B. Zachary Company of San Antonio, Texas. Construction has already begun.

The 63-mile pipe line will extend from the gas fields in San Salvador to the Carthage synthetic gasoline plant at Brownsville, Texas.

L. H. Prichard Dies

L. H. Prichard, chairman of the board of Anderson-Prichard Oil Corporation, died June 19 in Oklahoma City, Oklahoma. He retired as president of the corporation in 1946. He was president of the Col-Tex Refining Company, a corporation jointly owned by Anderson-Prichard Oil Corporation and the Standard Oil Company of Texas.

Survey to Determine Synthetic Fuels Plant Sites; Schroeder's Views Listed

Work has been started on a national survey of resources for a domestic synthetic fuel industry, which will be made for the U. S. Army by a group of engineering firms headed by Ford, Bacon & Davis, Inc., New York. About 75 men will be employed on the survey, and work is scheduled to be completed in 18 months.

For the project, the Army awarded a $1,341,637 contract, which includes subcontracts with four other engineering firms and an independent consultant. The survey will determine extent and nature of deposits of coal, natural gas, oil shale, and oil-impregnated strippable deposits which might be available for making synthetic liquid fuels. It will also provide information on water supply, power supply, transportation, housing, availability of labor, and other factors. Data will be obtained from federal, state, and local governments; mining, oil, railroad, and drilling companies; universities and colleges. Data will be correlated, analyzed, and tabulated for a national report and reports by states, indicating general areas suitable for plants. The studies will cover 37 states and Alaska. Thirty of these have "substantial" raw material deposits, according to Dr. W. C. Schroeder, chief of the Bureau of Mines' Synthetic Liquid Fuels office.

Snythetic Possibilities

Dr. Schroeder's view is that in less than a decade, shortages of domestic petroleum can appear, but the problem could be satisfactorily solved by development of synthetic liquid fuels.

Four courses available to prevent shortages, he said, are 1) importation of petroleum, 2) secondary recovery, 3) development of tidelands oil, and 4) and most important, development of synthetic liquid fuels. This would insure a liquid fuel supply independent of foreign sources and adequate for centuries, he explained, as well as provide a new American industry.

Refined products such as gasoline, diesel oil, and heating oil can be made from coal and oil shale for as little as 8.4 to 12 cents a gallon, he claimed. His estimate:

Excluding profit and interest on plant investment, gasoline can be produced from coal at costs ranging from 9 to 12 cents per gallon with plant investment between $7000 and $8500 for each barrel of capacity per day for plants of 10,000 barrels capacity and over.

Cost of crude shale oil, excluding profit and interest on investment, is $2 per barrel. From this the cost of gasoline, diesel oil, and heating oil made from the crude shale oil would be about 8.4 cents per gallon with initial plant investment between $4000 and $5000 per barrel per day capacity.

Oil shale products mining costs would be less than 60 cents per ton of shale, with mechanized methods permitting output of over 100 tons per man day underground.

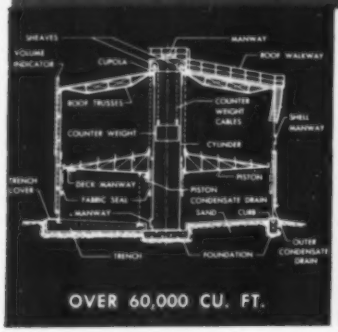
Seventy-five to 85 percent of crude shale oil can be converted economically into gasoline, heating oil, and diesel fuel. Retorting of oil shale still needs considerable study to determine the most efficient equipment.

Pulverized Coal Made "To Flow Like Water"

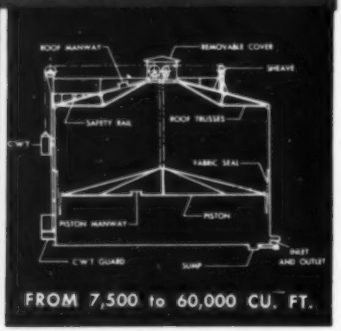
The Department of the Interior Bureau of Mines has announced that by a new method of coal feeding, pulverized coal is made to flow like water through a pipe to a generator producing the synthesis gas required for the manufacture of synthetic liquid fuels.

When a bed of finely powdered coal is agitated to a "boil" by an air current, it can be fed into the generator at a

WIGGINS *Dry Seal* GASHOLDERS



OVER 60,000 CU. FT.



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have proved a profitable investment, because they offer . . .

1. A Gasholder with efficient operation and easy maintenance.

a. Not affected by snow load since all moving parts are under cover.
b. All major moving parts accessible for inspection during operation.
c. A vapor balancer that can be made gas free for repairs in a few hours.
d. A vapor seal that has a life equal to that of the tank.
e. A Gasholder working pressure of ⅛ to ¼ inch of water.

2. A vapor balancer that has a 100% Dry Seal.

a. Eliminates corrosion problems attendant with wet seals.
b. Requires no heating system during freezing weather.
c. Has no evaporation loss through a water or oil seal.
d. Requires no attention, adjustment or lubrication.

3. One vapor balancing mechanism for all tanks.

a. Provides flexibility of operation.
b. Permits repair of any tank in group without affecting operation.
c. Allows vapor balancer to be removed without disturbing storage tank operation.
d. Accomplishes all venting through one master valve.
e. One structure for protection of all standing and pumping loss.

For more complete details and Pay-Out Analysis, write for Bulletin VB-10

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THE MONTH . . .

constant instantaneous rate, which is unattainable with mechanical feeders, it was explained.

With this new feeder, the quantity of coal that can be conveyed by one cubic foot of air is about 30 times that previously obtained in conveying practice. It may also be applicable for other finely divided solids.

Rubel Favors Shale Oil Plant Financed by U. S.

A. C. Rubel, Union Oil Company vice president in charge of exploration and production, has given his support to the proposal that the U. S. government finance, and that private industry build and operate a demonstration shale oil retorting plant and refining installation capable of producing about 8000 barrels daily of usable product.

While Rubel favored a demonstration plant of this size, he said there is no room for a full-scale synthetic liquid fuels industry at this time, but warned that such might become necessary in case of a war emergency.

"What is suggested is a subsidized plant of sufficient capacity to demonstate the commercial feasibility of oil shale production without attemping to compete with natural crude," he said. "A few years of operation of such a plant would develop the technique, machinery, economics and 'know-how' of shale oil production so that in an emergency the plant could rapidly be expanded to any required capacity with a minimum of time, material and manpower."

New "K" Value Announced For 85 Percent Magnesia

A new "K" value for 85 percent magnesia is announced in the Magnesia Insulation Manufacturers Association *News* dated June 1 as follows:

"Measurements made by the National Bureau of Standards about 1919 on the thermal conductivity of 85 percent magnesia insulation having a density then typical, 19.3 pounds per cubic foot; yielded a k-value of 0.51 at a mean temperature of 86° F. A test made earlier this year by the Bureau on 85 percent magnesia block insulation of current manufacture, weighing 13.2 pounds per cubic foot, indicated a k-value of 0.39 at 130° F. mean temperature. The conductivities, or k-values, cited above are expressed in units of Btu. per hour per square foot, for a temperature gradient of one degree F. per inch of thickness."

Beesemyer Selected to Arrange 1950 API Meet

Western Oil and Gas Association has appointed Clarence S. Beesemyer, executive vice president of General Petroleum Corporation, as general chairman of the committee in charge of arrangements for the 1950 annual meeting of the American Petroleum Institute.

The 1950 API session will be held in Los Angeles, the first time a point other than Chicago has been chosen as host city since before World War II.

THE MONTH...

Indiana Standard Observes Its 60th Anniversary

"Jobs, security, human happiness—these are 'profits' distributed in the 60 years past that have not appeared in the accounts but have been added to the permanent social assets in the nation's balance sheet."

Thus Dr. Robert E. Wilson, chairman of the board of Standard Oil Company (Indiana) keynoted the 60th anniversary observance, June 18, of the company's incorporation in 1889.

In celebrating the occasion, inscribed souvenir fountain pens were given to each of Standard's 27,000 employes. To the 97,000 stockholders were given anniversary leaflets with pictures of the nine executive heads of the company since its beginning. Standard's pictorial history was presented in a special anniversary issue of the employe magazine, *Standard Torch*, which told what the company's 60-year progress has meant to its employes, stockholders and customers.

The company now has five refineries and is marketing through its subsidiaries in 25 states.

"From its beginning, as a half-million corporation, Standard of Indiana has grown about 3000-fold," said A. W. Peake, president. "Now at the end of its 60th year, production figures are at an all-time high."

Three Promotions Listed By Standard of Indiana

C. F. Smith, superintendent of the light oils division of the Whiting, Ind., refinery of Standard Oil Company (Indiana), has been promoted to assistant general superintendent of the Whiting refinery. He succeeds Roy J. Dowoky, who has become executive assistant to the president and a director of Pan American Petroleum Corporation, a Standard subsidiary with headquarters at New Orleans.

C. E. Evans, assistant superintendent of the light oils division at the Whiting refinery, succeeds Smith, and Dr. Ford H. Blunck, general foreman of the pressure stills department in the light oils division at Whiting, succeeds Evans.

Cities Service Refining Division Picks Cravens

W. T. Cravens has been appointed assistant general superintendent of the refining division of Cities Service Oil Company of Delaware. Cravens, who received his bachelor of science degree in chemical engineering, from the University of Arkansas, has been with Cities Service companies for 12 years, having worked at Shreveport, Lake Charles, and recently in the New York office for Petroleum Advisors, Inc.

Lab Director Named

E. F. Schwarzenbek has been appointed director of the Petroleum & Chemical Research Laboratory of The M. W. Kellogg Company in Jersey City, N. J.

The Wiggins Lodek Floating Roof

... designed specially for the storage of corrosive oil products. The entire under surface being in complete contact with the tank contents, no vapors are trapped or can collect beneath the roof.

The basic exclusive conservation features of the Hidek Roof including the triple seal and extra large pontoons are retained.

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Write for bulletin FR-3 which gives further details on Wiggins Lodek Floating Roofs.

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FRANCE: Etablissements Delattre & Frouard réunis, Paris
CANADA: Toronto Iron Works Ltd., Toronto

THE MONTH . . .

Atomic Research Activity Under Way at Kellogg's

New laboratory facilities for chemical and physical research by the Kellex Corporation for the U. S. Atomic Energy Commission are now in operation at the Jersey City, N. J., plant of the M. W. Kellogg Company, parent company of the Kellex Corporation.

The Kellex studies form part of the commission's research, development and construction program which is aimed at the improvement of chemical separation of plutonium from uranium. The new research facilities will enable the development and testing on a laboratory scale of certain chemical processes concerned with this nuclear reactor development program.

Dennis Engineering Picks Skelly to Head Division

Lawrence E. Skelly is now managing the recently expanded facilities of E. L. Dennis Engineering Company of New Orleans which includes in the process division, engineering services to refineries, natural gasoline plants, chemical plants and allied industries.

Skelly graduated from the University of Toronto in 1936, having majored in thermodynamics. During the war he served in the United States Navy as assistant chief of engineering and planning for the special projects division of Chemical Warfare Service. He was formerly engaged in process engineering on chemical plant design and construction.

Corrosion Engineers Will Hold Meeting in Dallas

Among the technical papers on corrosion problems planned for the annual meeting of South Central Region, National Association of Corrosion Engineers, Dallas on October 3 and 4 are the following:

"Selection of Protective Coatings for Fume Resistance," by C. C. Harvey, Ethyl Corporation, Baton Rouge, La.

"Internal Corrosion of Crude Oil Tanks," by W. H. Crenshaw, American Inspection Service, Midland, Texas. This paper is sponsored by the Permian Basin Section NACE members of which are assisting in collecting data.

"Control of vapor Zone Corrosion in storage Tanks by the Use of Ammonia," by S. T. Gardner and A. T. Clothier of The Carter Oil Company and Francis Crovell of Interstate Oil Pipe Line Company, Tulsa.

"Thermofor Catalytic Cracking Gas Plant Corrosion Survey," C. A. Murray, The Pure Oil Company, Nederland, Texas.

"Combating Corrosion in a Chemical Plant with Magnesium Anodes," Oliver Osborn, The Dow Chemical Company, Freeport, Texas.

A panel-type discussion will be devoted to problems in pipe lines, refining, chemical, water works, production, transportation and other industries.

Corrosion Short Course

A "Short Course on Corrosion," scheduled September 12-16 at the University of Texas, Austin, is being sponsored by the National Association of Corrosion Engineers, and is directed principally to persons in industry who must deal with corrosion problems, but who have not had the experience or a background to do so effectively.

Dr. Norman Hackerman of the university faculty is assisting officers of the NACE South Central region in making arrangements. Dr. Hackerman says the course will be useful as a refresher in the fundamental phenomena with which the corrosion of metals is concerned.

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

Trends in Week Ended	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1948:									
January 31	5,318	5,434	228,083	15,986	102,973	7,690	40,580	9,141	50,859
February 28	5,387	5,463	226,860	15,796	111,040	7,963	33,836	8,824	49,206
March 27	5,377	5,334	229,409	15,783	112,991	7,882	30,717	8,854	48,334
April 24	5,418	5,517	228,488	16,515	111,128	8,321	34,237	8,877	49,572
May 29	5,452	5,715	228,979	17,827	107,185	7,084	38,641	9,508	55,146
June 26	5,494	5,674	229,632	17,938	104,178	7,200	45,166	8,858	58,812
July 31	5,455	5,718	230,720	17,646	99,116	6,823	56,661	9,080	65,713
August 28	5,529	5,682	229,873	17,722	95,504	7,491	66,321	8,818	70,853
September 25	*5,343	4,789	*234,193	15,100	78,669	5,997	61,884	6,380	37,326
October 30	5,604	5,626	239,702	17,569	91,925	7,679	81,593	8,853	81,299
November 27	5,617	5,721	244,246	17,317	89,802	7,476	85,151	9,477	88,192
December 25	5,641	5,784	250,555	18,178	100,286	7,776	79,271	9,121	86,181
1949:									
January 29	5,493	5,490	255,459	17,531	114,677	7,547	67,432	8,178	84,462
February 26	5,401	5,412	261,965	17,621	124,382	7,430	57,746	8,225	80,246
March 26	5,188	5,353	266,506	17,417	128,087	6,167	48,721	8,305	58,792
April 30	4,980	5,273	271,255	17,969	124,787	6,681	49,959	8,185	60,174
May 28	4,951	5,297	275,190	18,324	120,661	5,943	55,971	8,144	63,758
June 25	4,944	5,322	‡276,956	18,462	115,715	5,148	†63,049	7,856	†66,146

* Total U.S. All other September 25 figures do not include California, due to strike.
† Fuel oil stocks on new basis since March 26, 1949, and not comparable with previous totals.
‡ Crude Stocks: June 18.

Sabine Area Engineers Organize; Barrett Head

The Sabine Area Chemical Engineers Club has been organized by some 85 chemical engineers gathered at Port Arthur, Texas, and including members of the American Institute of Chemical Engineers residing in the general area centered around Port Arthur, Orange and Beaumont. Clark Barrett of the Sabine River Works of DuPont at Orange was elected chairman. Other officers include the following from Magnolia Petroleum Company's Beaumont refinery: Carroll O. Buttrill, chairman-elect; Hal A. Lund, secretary-treasurer; and G. Emery Springer, member of the executive committee. They will serve until June 1, 1950.

Mutz Named Vice President

Edward H. Mutz, assistant treasurer of Sinclair Oil Corporation since 1943, has been elected vice president of the corporation. He joined the company in 1920.

Old PR's Wanted

Texas Engineers Library, College Station, Texas, has asked help in the matter of locating back issues of PETROLEUM REFINER, in order to complete its files.

Needed are the entire volumes 1 through 21.

Also Nos. 1 through 6 of Vol. 22 are needed.

Also Nos. 9, 10 and 12 from Vol. 24.

"We would appreciate any help extended us in obtaining these back numbers either by gift or purchase," Librarian Robert E. Betters, said.

The State Board of Registration for Professional Engineers and the Texas A.&M. College cooperate in maintaining the Texas Engineers Library.

Ethyl's Schaefer Elected Research Institute Head

John H. Schaefer, Ethyl Corporation vice president in charge of manufacturing, recently was elected president of the Industrial Research Institute. Vice president of the Institute last year, Schaefer has been associated with Ethyl Corporation for 23 years and has been a vice president of the company since 1943. He lives in Baton Rouge, La., where Ethyl's antiknock manufacturing plant is located.

The Industrial Research Institute, composed of more than 110 companies representing varied industries, is interested primarily in establishing high standards in industrial research and in developing improved techniques of organization and operation in research.

Ethyl Hikes Octane Rate

Ethyl Corporation has announced that, as of September 20, the minimum standard for "Ethyl" gasoline will be 86 octane number by the ASTM Research Method, instead of 78 octane number (Motor Method) required since 1945.

The corporation explained that "broad changes" have occurred in design of motor car engines and in refining of gasoline since the Motor Method came into use. Also, the end of postwar shortages in oil and lead supplies has cleared the way for higher quality gasoline, Ethyl's announcement said.

In the certain high altitude marketing areas of Montana, Idaho, Wyoming, Nevada, Utah, Colorado, New Mexico and extreme western sections of Oklahoma and Texas, however, the new minimum standard will be 83 octane number, Research Method.

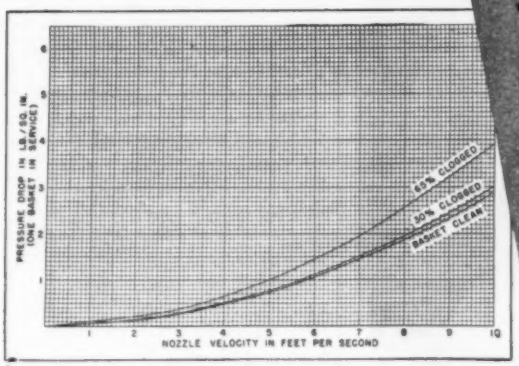
Young Succeeds Page

W. R. Young has been appointed Manager of the Federal Taxation Division of the Legal Department of The Texas Company, succeeding G. R. Page, who has retired after nearly 32 years of service with Texaco.

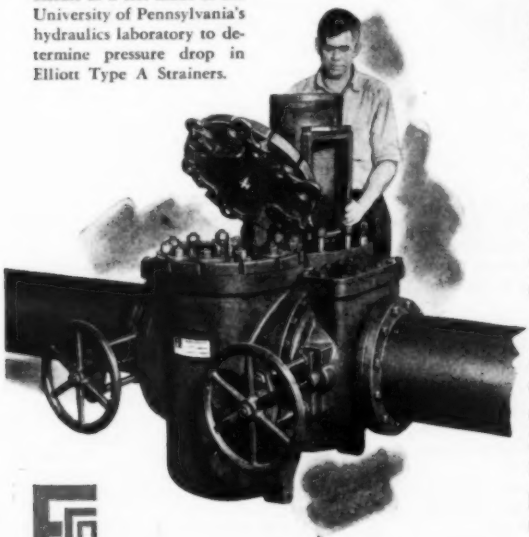
Young was first employed by The Texas Company in 1942 as a tax accountant and was appointed Assistant Manager, Federal Tax Division, in 1945.

LOW *Pressure* DROP WITH

THE NEW **Elliott** TYPE A TWIN STRAINERS



Result of a test made at the University of Pennsylvania's hydraulics laboratory to determine pressure drop in Elliott Type A Strainers.



STREAMLINE design of the strainer body and valve housings offers a minimum resistance to the flow of the liquid resulting in low pressure drop.

Larger basket area — approximately 5 to 1 ratio with standard mesh — further reduces the resistance to the liquid flow. This means a pressure drop of less than 2 feet of water at a velocity of 4.5 feet per sec when the basket is sufficiently clogged to require cleaning, as shown by the above curves plotted from tests on this strainer.

These new strainers have other advantages, too, in easier servicing, two-way gate valves that really seal, longer life, and most satisfactory operation all around. They're well worth checking into. Elliott Twin Strainers are available in sizes 1″ to 24″ for 125 lb pressure and 1″ to 12″ for 250 lb pressure. Full details in the interesting new bulletin, on request. Mail the coupon below.

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THE MONTH . . .

Bryan Announces Agreement For Plant Work in Japan

A working agreement whereby Thomas Bryan & Associates, engineers and contractors of Houston, "will collaborate with Nippon Kihatsuyu Kabushiki Kaisha (better known in America as Japan Gasoline Company, Ltd.) in the engineering design and reconstruction of Japan's chemical processing and petroleum refining industries" has been announced by Thomas S. Bryan, president of the Houston company.

According to Masao Saneyoshi, president of the Japanese company, virtually all of Japan's larger refineries were destroyed by bombing during the war or were so seriously damaged as to require dismantling.

A small part of Japan's refined products needs is now supplied by refineries located in the Japan Sea coast producing area, but the few remaining refineries in the Pacific coast and Inland Sea areas of the country were closed by military directive when occupation troops moved into the islands.

"For these reasons Japan's oil companies have little chance of resuming their important prewar position as importers of crude oil and exporters of refined products unless 1) Japanese companies can make new agreements with foreign oil companies for a crude supply and 2) new plants are built to refine these imports," Bryan said.

"Progress in negotiations looking toward this end are reported and we believe that present restrictions may soon be lifted to permit operation of Japanese refineries. Mr. Saneyoshi has advised us that Nippon Oil Company and Caltex are two of the companies engaged in current negotiations. He has reported others as Showa Oil Company and Shell, Toa Fuel and Standard Oil, Mitsubishi Oil and Associated Tide Water; and others."

The need for new and modern refineries in Japan, Bryan pointed out, depends upon the occupation government's willingness to permit Nipponese companies again to export refined products to Asiatic countries.

"Our Mr. (A. C.) Atwater, manager of the company's chemical and petroleum division, spent considerable time in Japan before the war and we hope he will figure prominently in the refinery rebuilding program there," Bryan continued. "In the meantime there is immediate need of extensive repairing and modernization of facilities that are operating for domestic supply."

The Bryan firm already has completed plans for three small fatty oils refineries in Japan and design work is going forward on various other chemical and industrial plants there.

Egloff Honored by AIC

Dr. Gustav Egloff of Universal Oil Products Company, who last month was awarded honorary membership in the American Institute of Chemists, presented an address, "The Future of the AIC."

Dr. Egloff served as AIC president from 1942 to 1946.

THE MONTH...

Barker Named Engineer

Campbell B. Barker has been named plant engineer and Owen B. Rowley has been named maintenance foreman for the Burnell-North Pettus cycling plant near Pettus, Texas.

The Burnell-North Pettus plant is in the Texas-Louisiana Gulf Coast division and is being built under the supervision of Stanolind Oil and Gas Company. It will be operated by Stanolind for the co-owners and is expected to be completed this summer.

Texaco Elects Three

Officials elected by The Texas Company and announced last month include:

L. H. Lindeman, treasurer, with the company since 1910, elected a vice president in charge of financial matters.

Robert Fisher, also with the company since 1910, and assistant treasurer for 10 years, named as treasurer.

A. C. Long, assistant to the chairman of the board, elected a vice president in charge of all foreign operations in the Eastern Hemisphere. Long's 20 years with the company has been principally in foreign work.

Beck Succeeds Auster

Charles Roy Auster, assistant purchasing agent in charge of domestic assignments, has retired from Socony-Vacuum Oil Company, Inc. after 45 years service with the company.

Earl W. Beck, who has been assistant purchasing agent in charge of foreign assignments, becomes assistant in charge of both domestic and foreign purchasing. He has been associated with the company since 1923.

Warner Named by Carnegie

Dr. J. C. Warner, dean of graduate studies and head of the chemistry department at Carnegie Institute of Technology, last month was named president-elect to succeed Dr. Robert E. Doherty, who will retire as Carnegie's president next year.

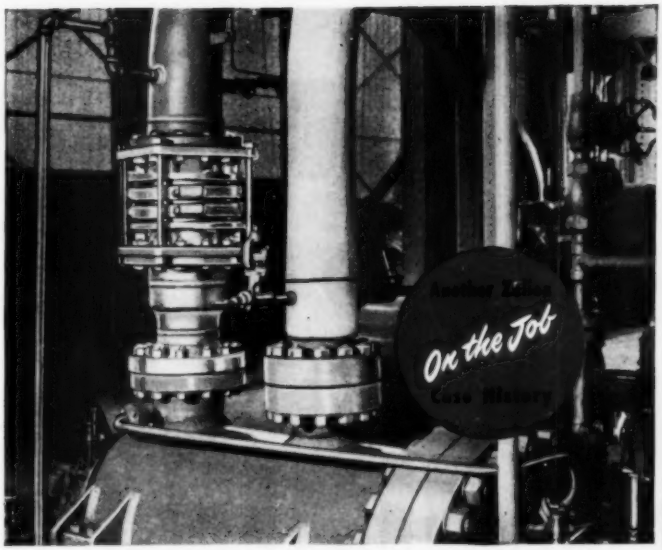
Dr. Warner will fill a newly-created office of vice president until his inauguration after Dr. Doherty's retirement, July 1, 1950.

Named ASME Chairman

R. L. Nichols, instrument shop foreman at Magnolia Petroleum Company's Beaumont, Texas, refinery, has been named area vice chairman of the South Texas section of the American Society of Mechanical Engineers. His area covers the Beaumont, Orange, Port Arthur triangle. Nichols has been associated with Magnolia since 1916.

F. A. Leovy Dies At Home

Frank Adair Leovy, 79, former vice chairman and director of Gulf Oil Corporation, former chairman and director of Gulf Refining Co., and president and director of a number of Gulf subsidiaries, died at his home in Pittsburgh June 2.



Another Zallea Repeat

WHEN West Penn Power Company added No. 7 Unit to its Springdale, Pa. Station in 1945, Zallea Stainless Steel Expansion Joints were installed to provide for expansion of the piping. Three years later, West Penn *again* selected Zallea Joints for use in its new Mitchell Station at Courtney, Pa. And, a second unit at Mitchell, now under construction, is *also* being equipped with Zallea Stainless Steel Expansion Joints.

Here, as in hundreds of cases, satisfied repeat customers continue to specify Zallea when they want the utmost in economy, dependability and long service life. *There's no packing to deteriorate . . . no maintenance required.*

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Recent developments in the field of organic chemistry have resulted in many new processes which have made necessary a wide variety of catalysts. Harshaw pioneered in the development of preformed catalysts. Not only do we have wide experience in the development and use of tabletted and extruded catalysts, but in addition, we have a large capacity for producing them. If you have a catalyst problem, a discussion with us may be helpful.

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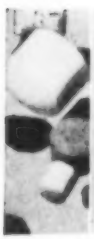
Tungsten Alumina — Cobalt — Copper — Magnesia — Nickel — Vanadium



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SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.

These abstracts are selected from the current literature of science and technology, not including trade journals easily available. Photostatic copies of original articles will be supplied at cost by The Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, also will be prepared and furnished by arrangement with the Laboratories.

Fundamental Physical and Chemical Data

Entropy and Heat of Formation of Hydrocarbon Vapors. MOTT SOUDERS, JR., C. S. MATTHEWS, AND C. O. HURD. *Ind. Eng. Chem.* **41** (1949) pp. 1048-56.

The authors have developed correlation methods for the prediction of entropies and heats of formation of hydrocarbon vapors on the basis of molecular structure. Values for the various structural groups necessary for the prediction of these thermodynamic properties under standard conditions and for the prediction of their change with temperatures up to 2000° K. are given in tabular form. Standard state entropies of formation predicted by the correlation method are believed to be within ± 1.0 entropy unit of correct value, regardless of the complexity of the molecule studied. Standard state heats of formation as predicted by the correlation are believed to be within ± 0.5 kg.-cal. per mole. The temperature effect on each of the thermodynamic functions is believed to be predicted with an uncertainty of less than 3 percent.

Raman Frequencies of n-Paraffin Molecules. San-ichiro Mizushima and Takehiko Simanouti. *Jour. Am. Chem. Soc.*, **71** (1949) pp. 1320-4.

The change of Raman spectra of the n-paraffins upon solidification can readily be explained if we assume the existence of only one molecular form in the solid state and of several forms in the liquid state. Molecular form in the solid state has been shown to be the extended form for which the calculation of normal vibrations has been made. Raman spectra of the n-paraffins in the liquid state is presented in tabular form including hydrocarbons from n-butane to n-cetane. In conclusion the authors discuss the subject of high elasticity as a property of substances of high molecular weight. The difference between polyisobutylene, which shows highly elastic properties, and polyethylene, which does not show elastic properties, is explained.

The Ultraviolet Absorption Spectra of Aliphatic Sulfides and Polysulfides. JOHN E. BAER AND MARVIN CARMACK. *Jour. Am. Chem. Soc.*, **71** (1949) pp. 1215-8.

The ultraviolet absorption spectra of n-hexadecyl mercaptan, n-hexadecyl sulfide, n-hexadecyl disulfide, n-hexadecyl trisulfide, and n-hexadecyl tetrasulfide were determined in hexane solution. Spectra of sulfur in hexane and in ethanol solutions were also determined. Spectra of the polysulfides have been shown to vary markedly with the sulfur content of the functional group. Spectrometry may be useful in the qualitative identification and in the quantitative estimation of various organic polysulfides.

Relationship of Thermodynamic Properties to Molecular Structure. Heat Capacities and Heat Contents of Hydrocarbon Vapors. MOTT SOUDERS, JR., C. S. MATTHEWS, AND C. O. HURD. *Ind. Eng. Chem.* **41** (1949) pp. 1037-48.

A correlation method is presented that reproduces the modern experimental and statistical data accurately and is believed to give the best available approximation to the heat capacities of the more complex molecules. Values of heat capacity and heat content were calculated using this correlation for a wide variety of hydrocarbons and are tabulated as values at zero pressure. Values for the several structural groups necessary to the correlation method are tabulated for the temperature range — 250 to 3000° F. Tabulations of the latest values for common gases are included for ready reference. The differences between heat capacities predicted by the correlation and modern experimental measurements are in general less than 3 percent. Comparisons with heat capacities and heat contents calculated by the methods of statistical mechanics show differences that in most instances are less than 2 percent at 50° F. The data are presented in great detail in tabular form and a bibliography of 51 references is included.

A Rational Basis for the Viscosity Index System, Part II. J. TADAYON, E. W. HARDIMAN, AND ALFRED H. NISSAN. *Jour. Inst. of Petroleum*, **35** (1949) pp. 28-30.

The authors present an equation for determining the value of "n" in terms of viscosities of oil at 100° F. and 210° F., "n" is a factor which characterizes an oil without ambiguity and which the authors believe to be more satisfactory than the viscosity index. Where viscosities are shown at other temperatures than 100 and 210° F. the authors suggest the use of the ASTM chart for determining viscosities at 100 and 210° F. A nomogram is presented that permits the ready determination of the values of "n."

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The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

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2,5-Dimethyl-2,4-hexadiene
Cyclooctanone
1,3-Dimercaptobenzene
1,4-Dimercaptobenzene
2,5-Diisopropylbenzoic acid
2,5-Dimethylbenzoic acid
Hexafluorobutadiene
1-Decalone
1-Decalol
3,4,5-Trimethylphenol
Lauryl disulfide
4-6-Bis(chloromethyl)-1,3-xylene
2-Methyl-(1',2'-naphtho)-4,5-thiazole
2-tert.-Butyl-4-methoxyphenol
3-tert.-Butyl-4-methoxyphenol
Benzyltrimethylammonium butoxide
Benzylimidodi-(4-methoxyphenyl)methane
2,2-Difluoroheptane

Chemical Composition and Reactions

The Hydrocarbon Type Composition of Cracked Gasolines. H. C. RAMPTON. *Jour. Inst. of Petroleum*, **35** (1949) pp. 42-60.

A method of hydrocarbon-type analysis was developed for cracked gasolines and similar products. This permits the determination of groups of hydrocarbons, including aromatics, naphthenes, paraffins, non-cyclic olefins and cyclic olefins. Quantities of the individual members of each of these groups can be determined in most cases since the analyses are made on highly fractionated cuts of the molecular boiling range. The procedure is based on the following general scheme: a) Separation of naphthenes and paraffins from olefins and aromatics by selective adsorption, followed by naphthene and paraffin determination on fractions of selected boiling range; b) Hydrogenation of original cracked gasoline to convert olefins to paraffins and naphthenes without hydrogenation of the aromatic hydrocarbons; c) Determination of the aromatic hydrocarbons on fractions of selected boiling range

prepared from the hydrogenated cracked gasoline; d) Removal of aromatics in hydrogenated cracked gasoline by selective adsorption followed by paraffin and naphthene determination on fractions of selected boiling range; e) Estimation of alkenes and cyclenes from differences in the analyses of corresponding boiling range fractions in (a) and (d).

Relation of Structure and Effectiveness in Copper Deactivators. ROGER W. WATSON AND THEODORE B. TOM. *Ind. Eng. Chem.*, **41** (1949) pp. 918-23.

Recognition of the fact that metals, particularly copper, are oxidation catalysts for hydrocarbons has led to the recent development and use of protective agents called metal deactivators. These are used to treat copper-sweetened gasolines and also to treat certain industrial lubricants, such as circulating oils. The factors that affect the effectiveness of metal deactivators are listed and briefly discussed. Among the more effective copper deactivators are salicylaldehyde-1,2-diamine condensation products and their derivatives and dialkyldithiooxamides. A bibliography of the literature on metal deactivators is included.

Combustion of Hydrocarbons. Free Radical Chain Reactions. PAUL L. CRAMER AND JOHN M. CAMPBELL. *Ind. Eng. Chem.*, **41** (1949) pp. 893-7.

The relative susceptibilities of paraffins to knock, based on molecular structure, are directly proportional to the number of secondary and tertiary hydrogen atoms in the molecules. A similar relationship can be applied to olefins but because of additional factors introduced by the double bond, the agreement is poorer than with the paraffins. Comparatively high knock resistance of aromatic hydrocarbons is in accord with the highly inert character of aromatic hydrogen to reactions with both methyl and ethyl radicals. The knocking characteristics of hydrocarbons are discussed from the standpoint of a free radical mechanism, based on the relative amounts and reactivities of the hydrogen atoms contained in the hydrocarbon molecule. Some new data are presented on the comparative effects of tetraethyllead, iron carbonyl, and diethylmercury on the critical compression ratios of certain hydrocarbons.

Products: Properties, Utilization and Analysis

Antiknock Agents. H. A. BEATTY AND W. G. LOVELL. *Ind. Eng. Chem.*, **41** (1949) pp. 886-8.

The authors give a general review of the use of tetraethyl lead as an antiknock agent in gasoline. Approximately 85 percent of the gasoline used is treated with 1.5 ml. of tetraethyllead per gallon. It is claimed that the prevention of fuel knock burns the fuel more efficiently and results in an estimated saving of over 50,000,000 barrels of gasoline per year.

Inhibitor Concentration and Stability. R. H. ROSENWALD AND J. R. HOATSON. *Ind. Eng. Chem.*, **41** (1949) pp. 914-18.

Two general equations are given to express the relationship between extent of stabilization as measured by the accelerated oxygen bomb and inhibitor concentration. The applicability of these equations was demonstrated for thermally cracked and catalytically cracked gasolines with four antioxidants. The data are presented in detail in tabular and graphical form.

Inhibition of Deterioration of Cracked Gasoline During Storage. C. J. PEDERSEN. *Ind. Eng. Chem.*, **41** (1949) pp. 924-8.

Deterioration of cracked gasoline is caused by autoxidation of the hydrocarbon components. Initial oxidation products, formed through a series of free radical chain reactions, are peroxidic compounds that are converted into monomeric and polymeric oxygenated products. Antioxidants inhibit deterioration by reacting with chain-propagating free radicals. Because of the fact that antioxidants are destroyed in the process of terminating chain reactions and are also oxidized by some of the peroxidic compounds, they should be added to gasoline as soon as possible after cracking. The oxidation of gasoline containing antioxidants is greatly accelerated by salts of certain multivalent metals, particularly copper. These metals should be removed or deactivated in order to permit a minimum concentration of antioxidant in order to get adequate storage stability. Deactivators should be added to gasoline at the earliest moment, preferably prior to or simultaneously with the addition of the antioxidant.

Effect of Additives on Gasoline Engine Deposits. R. E. ALBRIGHT, F. L. NELSON, AND L. RAYMOND. *Ind. Eng. Chem.*, **41** (1949) pp. 897-902.

The authors investigated the effects of gasoline additives, such as antioxidants and tetraethyllead, on engine varnish and sludge deposits both in the laboratory and in field tests. Field tests have shown relatively insignificant differences in the deposit forming tendencies of several gasoline antioxidants. Laboratory tests show some gasoline antioxidants tend to increase engine varnish and sludge deposits. The extent of deposit formation is dependent on the hydrocarbon composition of the base gasoline. Tetraethyllead has no significant effect on varnish and sludge deposits as shown by laboratory tests. Fuel additives have been developed that show large reductions in engine varnish sludge formation which are not yet commercially available.

Sulfur-Tetraethyl Lead Interaction in Motor Fuels. H. K. LIVINGSTON. *Ind. Eng. Chem.*, **41** (1949) pp. 888-93.

Studies of hydrocarbon blends having octane numbers in the range from 40 to 95 and containing 0.1 to 6.0 ml. of tetraethyllead per gallon and 0.01 to 2.00 percent sulphur have led to these conclusions. The sulphur compounds having the sulphur atom or atoms in the same type of chemical combination have the same effect on tetraethyllead when fuels are compared at the same sulphur concentrations. The same fraction of tetraethyllead antiknock efficiency is lost for a given amount of a sulphur compound, independent of the total concentration of tetraethyllead. The loss in antiknock efficiency is independent of the octane number or composition of the base fuel. When more than one sulphur compound is present those containing sulphur in different types of chemical combination have an additive effect. The ratio of inactive to active tetraethyllead in a fuel containing thiophenic sulphur is directly proportional to the sulphur concentration; for other types of sulphur compounds, the ratio is proportional to a power of the sulphur concentration.

Utilization of 2,2-Dinitropropane as a Cetane Number Improver. R. E. ALBRIGHT, F. L. NELSON, AND L. RAYMOND. *Ind. Eng. Chem.*, **41** (1949) pp. 929-34.

The use of 2,2-dinitropropane for improving diesel fuel cetane number is discussed from the technical standpoint. The use of 2,2-dinitropropane appears satisfactory and pilot plant quantities of this material are currently available. Further utilization of 2,2-dinitropropane depends upon the future demands for diesel fuels of high cetane number and, possibly, upon reduction in the cost of the dinitropropane as a result of increased production to meet demands for uses other than the improvement of the number.

Oxidation Stability of Tetraethyllead and Leaded Aviation Gasolines. E. L. WALTERS AND C. I. BUSSO. *Ind. Eng. Chem.*, **41** (1949) pp. 907-14.

The authors endeavor to show individual and combined effects of tetraethyllead, inhibitors, and hydrocarbon components on the stability of aviation gasolines. Typical aviation gasoline base stocks were stable initially, but were rendered unstable by the addition of tetraethyllead. This effect was particularly marked in concentrations above 1 ml. per gallon, and persisted in blends that contained conventional amounts of reactive hydrocarbons and inhibitors. Further study indicated the tetraethyllead itself was extremely unstable towards oxidation. Preoxidation of tetraethyllead before blending may adversely affect stability and inhibitor susceptibility of the leaded gasoline.

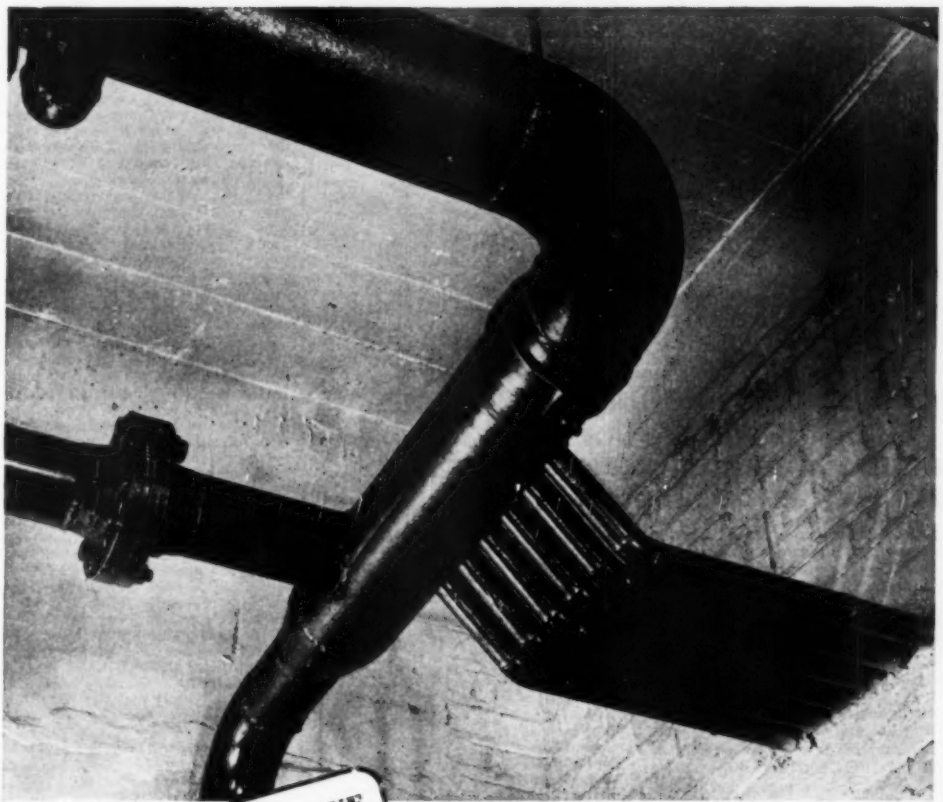
Stability Test for Additive-Treated Motor Oils. S. A. MCKEE AND ANN ROBINSON FRITZ. *Analytical Chem.*, **21** (1949) pp. 568-72.

The authors describe a laboratory test for rating lubricating oils that was developed at the Bureau of Standards. This test simulates the characteristic engine deposit formation significant in the engine testing of motor oils. Oil flows in a thin film at a regular rate and is recirculated for a definite time over a steel strip maintained at an elevated temperature. The strip is weighed before and after the test in order to obtain a numerical as well as a visual indication of the amount of the deposit formed. The strip was washed with precipitation naphtha to remove the oil film without removing the deposit. Straight motor oils and motor oils containing additives were tested. Additive oils included both premium and heavy-duty types. The test provides a reasonably sensitive measure of the effectiveness of inhibitors and detergents and their combinations. It is agreed that the tests improve the correlation of oils with engine performance.

Developments in Paint Oil Extenders. D. H. TULLIS. *Jour. Inst. of Petroleum*, **35** (1949) pp. 31-41.

The shortage of vegetable drying oils,

How to Tame a Tough Joint



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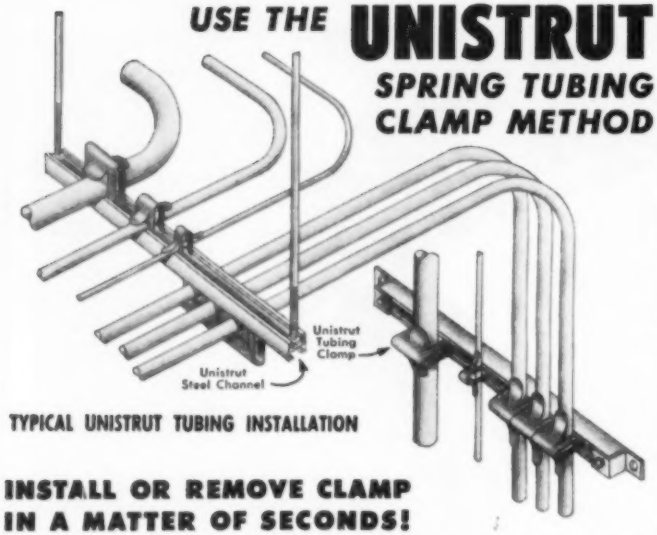

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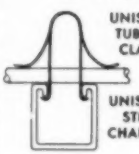

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particularly linseed oil, led during the war to a search for substitutes and extenders. The paper reports on observations made during experiments carried out to overcome some of the more marked deficiencies of aromatic petroleum extracts, when utilized as extenders in paints. The extracts used were all obtained from the Edeleanu plant. Another product used was the bottoms produced by re-running stabilized clay-treated sour cracked gasoline from a thermal cracking plant. This material is referred to as "polymer." When polymer is added to aromatic extract material the drying time is improved. Mixing of paint and testing of the product are described. Types of failure, such as crocodiling, blistering and chalking, are considered. It is concluded that polymer has considerable commercial application in the manufacture of paint, either by itself or in admixture with normal extract extenders.

Oxidation of Lubricating Oils at High Temperatures. G. H. Denison and O. L. Harle. *Ind. Eng. Chem.*, **41** (1949) pp. 934-7.

Most studies of lubricating oil oxidation have been made at temperatures corresponding to those in bearings and crankcases of engines. To extend this type of information to temperatures of the piston zone, techniques were developed for determining the rates of oxygen absorption at temperatures as high as 340° C. The rates of oxygen absorption in the temperature range 170° to 340° C. follow the law of Arrhenius within the accuracy of the experimental method. At piston area temperature 290° C. and an engine sump temperature of 90° C., the over-all oxidation rate in the piston area is 200,000 times that of the sump. All the oils tested show experimental activation energies for the initial step of oxidation from 33 kg.-cal. This is in agreement with figures given by other experimenters for reactions performed at lower temperatures on hydrocarbons.

Oxidation of Turbine Oils in the Laboratory. D. Wyllie and G. C. N. Cheesman. *Jour. Inst. of Petroleum*, **35** (1949) pp. 61-72.

The behavior of typical oils under oxidation test I.P. 114-47 has been observed both under the standard conditions and by use of a modified test. The possibility of substituting oxygen for air in the test is considered. Peroxides are not present in more than negligible quantities during the oxidation of a conventionally refined turbine oil, but the peroxide value of the oil rises on the conclusion of the oxidation. This can be explained if the rate of peroxide decomposition is high compared with the rate of peroxide formation during high-temperature oxidation but not at room temperature, although the oxidized oil is susceptible to peroxide formation at room temperature. The oxidation-corrosion test of Pope and Hall is not a suitable corrosion test for turbine oils, and the use of interfacial tension as a criterion of the extent of oxidation is not advised in view of the lack of correlation between interfacial tension and demulsification number. Promising results were obtained when the behavior of four pre-selective gear-box oils in oxidation

I.P. test 114-47 was compared with service experience. The data are presented in considerable detail in tabular form and a bibliography of 14 references is included.

Antiseizure Properties of Boundary Lubricants. R. E. THORPE AND R. G. LARSEN. *Ind. Eng. Chem.*, **41** (1949) pp. 938-43.

The antiseizure properties of boundary lubricants depend on the shearing of tightly bound films chemically formed in place on the surfaces of contact. Evaluation of lubricants in this respect can be easily measured by studying the variation of the coefficient of friction in various modifications of the four-ball apparatus. Friction of boundary lubricants is independent of sliding velocity in the low-speed range (0.1 to 8 cm. per second) or decreases slightly as the speed approaches zero. Poor boundary lubricants, that contain no polar components, or those containing polar molecules that adsorb physically only, are characterized by relatively high friction, that often increases at low sliding velocities to values that are characteristic of unlubricated surfaces. Effective boundary lubricants reduce metal pickup to very small values. The actual magnitude of the coefficient of friction under nonseizing conditions is determined to a large extent by the thickness of the adsorbed films of oil that the lubricant can maintain between the rubbing surfaces.

Deposition of Lacquer and Sludge in Passenger Car Service. F. F. FARLEY AND R. J. GREENSHIELDS. *Ind. Eng. Chem.*, **41** (1949) pp. 902-6.

Factors that influence sludge and lacquer deposits in engines operated at low temperatures are engine design, operating conditions, fuels, and lubricants, rated in the order of decreasing importance. The bad effect of low engine jacket temperatures in promoting sludge and lacquer formation has been established. At low crankcase temperatures lubricating oils do not contribute appreciably to deposition, and oxidation goes on at a negligible rate. Deposits are derived chiefly from incomplete combustion products of the fuel that pass the piston as blowby, condense in the oil film on the cylinder wall, and flow with the oil into the crankcase. As the crankcase oil is recirculated over the pistons oxidation and polymerization of intermediate combustion products proceeds and, simultaneously, lacquer on the pistons and sludge particles in the circulating oil form. Agglomeration and coagulation of sludge particles occur in the cooler and quieter parts of the engine. Winter operation of cars is at low crankcase oil temperature. In many respects, low temperature operation presents more difficult problems than high temperature operation.

Analysis of Gaseous Hydrocarbons. DANIEL MILSOM, W. R. JACOBY, AND A. R. RESCORLA. *Analytical Chem.*, **21** (1949) pp. 547-50.

An accurate method of gas analysis combining infrared and mass spectrometer techniques is described. The procedure can be applied to any gaseous mixture and is based on the fact that infrared analysis of isomeric compounds is faster and more accurate than mass spectrometer analysis and that the mass spectrometer is faster as well as more efficient in analyzing samples in which an isomeric breakdown is not required. Instruments can be calibrated in the normal way and used by standard procedures. Results of the analysis of research grade hydrocarbons, of synthetic blends, and of plant stream samples are presented in tabular form.

Accuracy and Precision of Analysis of Light Hydrocarbon Mixtures. C. E. STARR, JR., AND TRENT LANE. *Analytical Chem.*, **21** (1949) pp. 572-82.

Comprehensive testing of analytical methods for light hydrocarbons was conducted by the Rubber Reserve Committee on Butadiene Specifications and Methods of Analysis. The paper summarizes evaluation of analytical methods employed to control an analysis of feed stocks and products involved in the production of butadiene. Seventy laboratories performed 8000 tests employing such analytical tools as the mass spectrometer, infrared and ultraviolet spectrophotometers, low temperature fractional distillation, and many different chemical procedures. Appraisal of the data obtained under standardized conditions leads to the conclusion that each procedure has some unique advantage, but that by employing the most suitable methods high degrees of accuracy and precision can be obtained for the analysis of most of the common lighthydrocarbons. Most of the laboratories can check their results within a probable error of ± 0.2 to 0.3 mole percent. Typical data are presented in considerable detail in 15 tables. A bibliography of 14 references is included.

On the Properties of Paraffin Wax in the Solid State. W. M. MAZEE, *Jour. Inst. of Petroleum*, **35** (1949), pp. 97-102.

The author makes reference to articles by Minchin on the properties of paraffin waxes in the solid state, and indicates that the present article may serve as a complement of the facts already known and may thus contribute towards a better understanding of the constitution of paraffin wax. The behaviour of some binary mixtures of pure hydrocarbons is given. It was found that n-$C_{21}H_{44}$ and n-$C_{28}H_{58}$ form a continuous series of mixed crystals, whereas n-$C_{21}H_{44}$ and n-$C_{31}H_{64}$ form a eutectic so that n-$C_{31}H_{64}$ and n-$C_{28}H_{58}$ crystallize separately. A mixture of n-$C_{31}H_{64}$ and 13-methylpentacosane also give a binary system with a eutectic. On the strength of these phenomena and hypothesis is formulated on the structure of commercial paraffin waxes.

Normal hydrocarbons occuring in a wax from about $C_{21}H_{44}$ to $C_{36}H_{76}$ form mixed crystals in small groups. "Soft wax", **iso-** and **cyclo**paraffins, crystallize by the side of the mixed crystals, and possibly constitute a "lubricating film" between the crystals. By the formation of mixed crystals the transition point of the pure hydrocarbon is considerably lowered, and it is possible that part of the wax is present in the modification that is stable immediately below the melting point. An exact transition temperature cannot be expected in these cases, but a transition zone. Variations in the heat of transition of different waxes are discussed.

Nomographs for Paraffin-Naphthene Split in the Type Analysis of Gasoline. GEORGE W. THOMSON. *Analytical Chem.*, **21** (1949) pp. 644-5.

In the type analysis of gasoline by the method developed by Kurtz and his associates the relative proportions of paraffins and naphthenes in cuts that are free of aromatics and olefins are obtained from the index of refraction and density of the cuts. Volume percent of naphthenes in the solution is obtained from plots of the refractivity intercept against density. The author presents two nomographs that can be used in place of the former plots, which are easier to read and obviate the necessity of interpolating between the 10 percent lines of the plots. The procedure for using the nomograph is explained.

Science - Technology

Determination of Total Olefins and Total Aromatics. J. J. HEIGL, J. F. BLACK, AND B. F. DUDENBOSTEL, JR. *Analytical Chem.*, **21** (1949) pp. 554-9.

The authors employed the Raman lines characteristic of the aromatic carbon-carbon bond vibrations in the determination of total unsaturation and total aromatics. Analyses were made by scanning the spectral region with a Raman displacement of 1590 to 1680 units from the exciting line. Functions of the areas under peaks rather than peak heights are employed in both analyses, as the positions of the peaks shift with different olefins and aromatic compounds. Results are accurate for both compounds within ± 10 percent of the correct value.

Direct Determination of Oxygen in Petroleum Products. R. A. DINERSTEIN AND R. W. KLIPP. *Analyitcal Chem.*, **21** (1949) pp. 545-7.

The adaptation of the Schuetze-Unterzaucher method to the direct determination of oxygen in petroleum products is described. Decomposition vapors of a cracked sample are passed over carbon at 1000° C. and the resultant carbon monoxide is oxidized to dioxide with iodine pentoxide. Either the carbon dioxide or the iodine can be determined. The apparatus has been modified by enlarging the combustion tube to permit the use of larger samples, elimination of the conventional side arm on the combustion tube, and the use of an inexpensive commercially available furnace. Results are given for known and unknown compounds containing from 0.15 to 26 percent oxygen.

Manufacture: Process and Plant

Integration of Operations in a Large Refinery. K. B. ROSS AND D. N. MCKINLAY. *Jour. Inst. of Petroleum*, **35** (1949) pp. 3-27.

The authors describe the methods in use at Abadan for integrating the various operations of a large modern refinery. Abadan is believed to be the largest refinery in the world, having a crude oil capacity of 500,000 barrels per day. Among the subjects covered are crude-oil supplies, availability of the individual refinery units, crude-oil pumping, crude-oil distillation, size of distillation units, operation of distillation units, production of aviation gasoline, production of motor gasoline, production of kerosines and burning oils, production of tractor oil, manufacture of bitumen, production of petroleum specialties, the storage of products, chemicals, and utilities.

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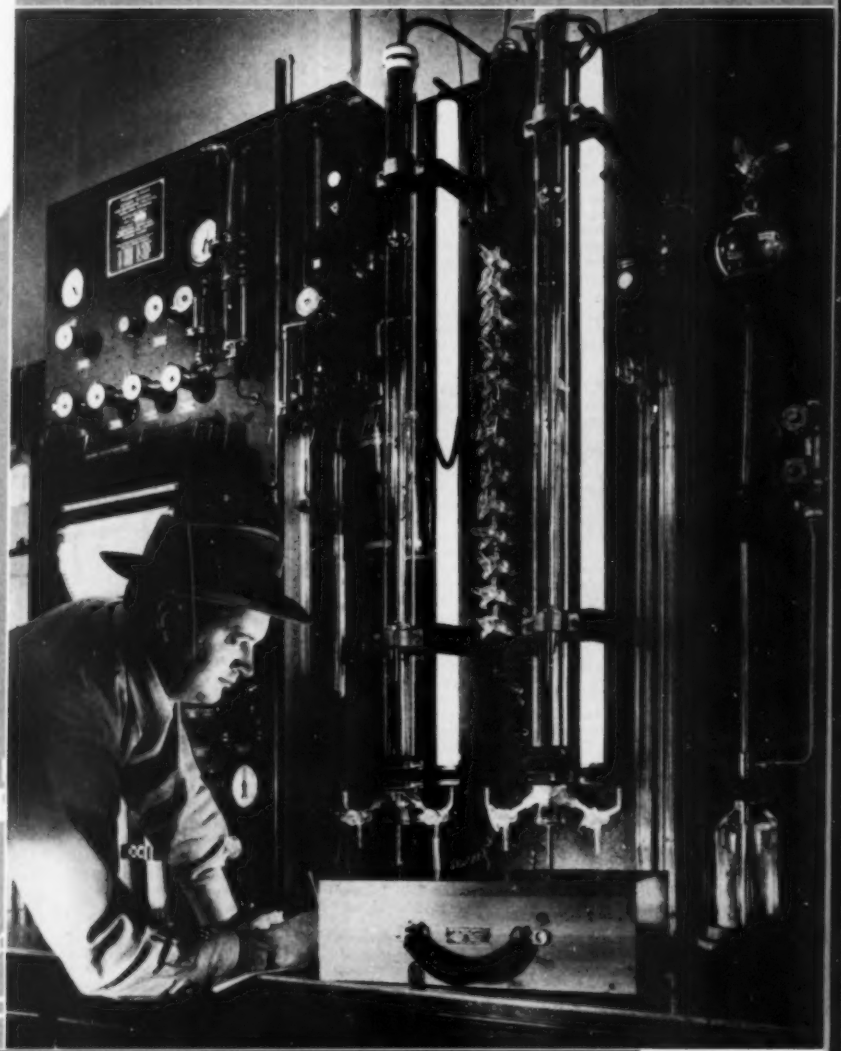

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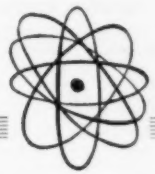
Crude Oil, Natural Gasoline and Liquefied Petroleum Products

Digest of Recent U. S. PATENTS Pertaining to PETROLEUM REFINING

Compiled by HEINZ HEINEMANN

(From the Official Gazette, April 12, 19, 26 and May 3 and 10, 1949)



REFINING

U.S.P. 2,466,699. Separation of Ortho-oxylene from Isomeric Xylenes by Fractional Distillation. W. L. Glowacki to Koppers Company, Inc.

Ortho-xylene of high purity is obtained from a mixture containing isomeric xylenes by fractionally distilling this mixture under particular conditions. A distillate fraction of a freezing point closely coresponding to that of pure o-xylene is collected. This product is o-xylene of above 90 percent purity.

U.S.P. 2,467,152. Distillation of Ethyl Benzene from Styrene. E. O. Ohsol and J. A. Patterson to Standard Oil Development Company.

A mixture of ethyl benzene and styrene is fractionally distilled, separating the bulk of the ethyl benzene from the styrene. The styrene bottoms containing traces of ethyl benzene are stripped and an azetrope former for the ethyl benzene is introduced into the lower portion of the stripping zone. Vapors of the azeotrope are passed through the distillation zone. Substantially pure styrene is recovered from the bottom of the stripping zone.

U.S.P. 2,467,197. Azeotropic Distillation of Styrene. K. H. Engel to Allied Chemical & Dye Corporation.

An oil mixture containing styrene and like-boiling alkyl benzenes is fractionally distilled in the presence of a glycol ether or ether-ester boiling between 120-150° C. A fraction of increased like-boiling alkyl benzene content and a higher boiling product of increased styrene content are recovered.

U.S.P. 2,467,198. Azeotropic Distillation of Styrene from Phenylacetylene. R. B. Greene to Allied Chemical & Dye Corporation.

Styrene oil containing phenyl acetylene is treated in about the manner as described in U.S.P. 2,467,197. A substantial portion of the styrene is distilled overhead.

U.S.P. 2,467,394. Purification of Halogenated Hydrocarbon Solvents. J. B. Lovell and M. C. Fuqua to Standard Oil Development Company.

Water-free halogenated hydrocarbon solvents, such as CCl_4 or ethylene dichloride, or mixtures thereof, as used in the dewaxing of petroleum oils, are freed from contaminating mineral acid by means of dry solid alkali pellets in a special process in which a salt of the acid is deposited on the surface of these pellets.

U.S.P. 2,467,845. Diolefin Extraction. C. E. Morrell and M. W. Swaney to Standard Oil Development Company.

A hydrocarbon mixture containing a C_8 and/or C_8 diolefin and an alkyl alpha-acetylene are contacted at 70-150° F. with a cuprous salt ammonia solution of particular composition. The amount of this solution is regulated so that no more than a small portion of the diolefin is dissolved while all the acetylene present is dissolved and thus removed from the hydrocarbon mixture. The undissolved olefins are separated.

U.S.P. 2,467,855. Method of Decomposing Acid Sludge. C. L. Read to Standard Oil Development Company.

Acid sludge recovered from the H_2SO_4 treatment of hydrocarbons is coked in a particular manner to produce coke and SO_2-gas.

U.S.P. 2,468,044. Solvent Extraction Process and Apparatus. H. R. Davis to The Lummus Company.

A particular process and apparatus are claimed for the countercurrent treatment of hydrocarbon oil with a solvent to separate the oil into extract and raffinate phases. A packed vertical extraction tower is used, and intermediate extract and raffinate phases are segerated at vertical sections throughout the tower.

U.S.P. 2,468,180-1. Process for Breaking Petroleum Emulsions. M. DeGroote and B. Keiser to Petrolite Corporation, Ltd.

A demulsifier including a cation-active polychloride of particular complex constitution and formation is employed for breaking petroleum emulsions of the water-in-oil type.

U.S.P. 2,468,638. Apparatus for Continuous Analysis of Fluid Mixtures. E. J. Rosenbaum to Sun Oil Company.

An apparatus is claimed for analytically determining the conjugated diolefin content of hydrocarbon gases. It is based on the use of continuous ultraviolet radiation of constant intensity produced by a hydrogen arc, certain radiation in the ultraviolet range being strongly absorbed by conjugated diolefins.

U.S.P. 2,468,750. Method of Separating Hydrocarbons. G. L. Gudenrath to Hudson Engineering Corporation.

The details of a method are claimed for separating C_8 and higher hydrocarbons from high pressure gas by absorbing the hydrocarbons from the gas in an absorption oil and separating methane therefrom.

U.S.P. 2,468,958. Apparatus for Treating Crude Oil Vapors. A. V. B. Candler to Maloney-Crawford Tank & Manufacturing Company.

The details of an apparatus are claimed for treating crude oil containing an emulsion, the apparatus serving for breaking the emulsion and separating the oil from water and gas.

U.S.P. 2,468,986. Preparation of Odorless Fractions of Highly Branched Paraffins. H. R. Lega'ski and C. C. Crawford to Phillips Petroleum Company.

An olefin-free charge stock containing a branched-chain paraffin fraction boiling at 350-400° F., higher and lower boiling branched-chain paraffins and oxygen, but free from sulfur and nitrogen contaminants is fractionally distilled. An odorous distillate obtained containing said fraction and lower boiling paraffins is introduced into an intermediate point of a fractionation column. An odorous stream of paraffins boiling below 350° C. is withdrawn from this column, while an odorless fraction boiling at 350-400° C. and forming the process product is removed as a kettle product.

U.S.P. 2,469,724. Hydrocarbon Fractionating. G. W. Gross to Standard Oil Development Company.

Details are claimed of a process for separating a complex mixture of C_7 to C_8 hydrocarbons with fractional liquefaction by increased pressure and fractional distillation of the pressure fractions obtained.

U.S.P. 2,469,737. Addition Agent for Gasoline. J. G. McNab and H. W. Rudel to Standard Oil Development Company.

A gasoline-containing motor fuel contains tetraethyl lead imparting anti-knock properties to the motor fuel and 0.01-1 percent by weight of a polymerized ester of an alpha-beta unsaturated acid having a molecular weight of at least 2000-30,000. This additive stabilizes the lead tetraethyl.

U.S.P. 2,469,751. Cold Starting Motor Fuel. W. J. Sweeney to Standard Oil Development Company.

Details are claimed concerning the composition of a priming fuel for starting gasoline engines at low temperatures. It comprises a liquid mixture of nor-

mally gaseous and low boiling paraffinic hydrocarbons.

CATAYLST PREPARATION, ACTIVATION, AND REGENERATION

U.S.P. 2,467,089. Preparation of Zirconia Gel. M. M. Marisic and E. M. Griest to Socony-Vacuum Oil Company, Inc.

A stable hydrogel or gel of zirconia, useful in hydrocarbon conversion catalysts, is prepared from an aqueous zirconyl chloride solution and an ammonium carbonate solution.

U.S.P. 2,467,162. Preparation of Aluminum Halide Catalyst. H. G. Schutze to Standard Oil Development Company.

Anhydrous aluminum halide is heated to 150-300° F. to decompose hydrates of the halide. The hydrolysis decomposition products are removed by contact of the aluminum halide with vaporous alkyl halide and the aluminum halide is then dissolved in a liquid alkyl halide.

U.S.P. 2,467,283. Fischer-Tropsch Catalyst and Its Preparation. B. R. Warner to Gulf Research and Development Company.

This patent claims the catalyst used according to U. S. P. 2,467,282 in the Fischer-Tropsch synthesis, and the process for preparing the catalyst in the manner described. The catalyst is characterized by its enhanced activity and lower CO_2 production during the hydrocarbon synthesis.

U.S.P. 2,467,326. Production of Branched Chain Hydrocarbons Catalyzed by Friedel-Crafts Catalysts Modified by Boric Acid. J. M. Mavity to Universal Oil Products Company.

A reactive hydrocarbon is subjected under conversion conditions to the action of a catalyst prepared by reacting boric acid and a metal halide of the Friedel-Crafts type under evolution of hydrogen halide. The new catalyst is, for example, useful in alkylation processes, in the isomerization of paraffins and in the polymerization of olefins.

U.S.P. 2,467,470. Manufacture of Spherical Particles. C. G. Gerhold and L. A. Mekler to Universal Oil Products Company.

A spraying and drying apparatus is claimed for forming spherical particles to be employed as catalysts in hydrocarbon reaction processes.

U.S.P. 2,467,484. Method of Regenerating Dehydrofluorinating Catalysts. E. R. Kanhofer to Universal Oil Products Company.

Metallic dehydrofluorinating catalysts, used in the removal of fluorine compounds from alkylated hydrocarbons or the like, are reactivated by contacting them with anhydrous HF at a pressure and temperature to maintain the HF in the liquid phase. Resinous deposits are removed by this treatment from the metallic catalyst, e.g. a metallic Al-catalyst.

U.S.P. 2,468,756. Hydrogen Fluoride Recovery Process. J. O. Iverson to Universal Oil Products Company.

A contaminated HF-catalyst containing water and relatively heavy organic material is regenerated by means of preheated light hydrocarbon vapors passing countercurrently to the contaminated catalyst in a fractionating column at a temperature sufficient to decompose organic fluorine compounds and to vaporize HF.

U.S.P. 2,468,857. Process of Making Spheroidal Gel Particles. J. A. Anderson and V. Vorhees to Standard Oil Company of Indiana.

An inorganic oxide sol capable of gelling is sprayed into an atmosphere of condensable vapor. The sol is formed into spheroidal droplets within this atmosphere and vapors included with the still liquid droplets are condensed. The droplets are maintained in suspension until gelling has taken place. The dried gel particles are useful as catalysts and adsorbents.

U.S.P. 2,469,314. Catayst for Cracking Hydrocarbons. L. B. Ryland and M. Tamele to Shell Development Company.

A catalyst for cracking hydrocarbon oils essentially consists of a homogeneous synthetic silica-alumina composite with 18-38 percent alumina. The catalyst has an average pore diameter of at least 50 A, a surface of at least 400 $m.^2/gm.$ and a particle density below 0.95 gm./cc.

CRACKING AND REFORMING

U.S.P. 2,466,706. Cracking Hydrocarbons in the Presence of Fluoborate Catalyst. E. C. Hughes and S. M. Darling to The Standard Oil Company of Ohio.

Hydrocarbons boiling above motor fuel range are cracked in the presence of a sodium or potassium fluoborate catalyst to form hydrocarbons of motor fuel boiling range. Good yields of these hydrocarbons and a reduction of coke and dry gas formation are obtained by the use of this catalyst.

U.S.P. 2,467,149. Handling Finely Divided Materials. J. C. Munday to Standard Oil Development Company.

A particular method of countercurrently contacting gaseous fluid with finely divided solid material is claimed, wherein a plurality of contacting zones is employed in series. The method is advantageous for example in the catalytic cracking of oils without the use of any moving parts.

U.S.P. 2,467,920. Production of Gasoline. H. H. Voge, B. S. Greensfelder and N. E. Peery to Shell Development Company.

Hydrocarbon oil boiling above gasoline range is catalytically cracked in admixture with a hydrogenated gas oil fraction. The reaction product is separated into a gaseous fraction, an olefinic gasoline fraction, and a refractory gas oil fraction. The latter is hydrogenated. The higher boiling fraction of the hydrogenated product is employed for admixture to the feed oil. The lower boiling fraction is mixed with the olefinic gasoline fraction for a second cracking operation to produce cracked gasoline.

U.S.P. 2,469,325. Conversion of Hydrocarbons. O. L. Branson to Socony-Vacuum Oil Company, Inc.

The details of a method are claimed for maintaining a uniform optimum cracking temperature in a moving bed catalytic cracking reactor during the conversion of a long boiling range mixture of hydrocarbons into high quality gasoline.

U.S.P. 2,469,733. Cracking Oil with Aerogel Catalysts. K. K. Kearby to Standard Oil Development Company.

Petroleum oil is contacted at a cracking temperature with a metal oxide catalyst (e.g. a compound of SiO_2 and Al_2O_3) in the form of an aerogel. Motor fuel of high anti-knock properties is produced.

ALKYLATION

U.S.P. 2,467,731. Production of Primary Alkylation Products in HF Alkylation. J. C. Dart, C. S. Kuhn, Jr., J. E. Penick and U. H. Wagner to Socony-Vacuum Oil Company, Inc.

A mixture containing isobutane, isobutene, butene-2 and butene-1 in definite proportions is treated in the presence of liquid HF at a temperature of —10° to +70° C., under special conditions claimed in detail, to condense the isobutane with the butenes in the liquid phase. Motor fuel of high octane rating is produced.

U.S.P. 2,468,529. Alkylation Process. A. Voorhies, Jr., and A. R. Sydnor, Jr. to Standard Oil Development Company.

A liquefied normally gaseous isoparaffin is alkylated with a liquefied normally gaseous olefin (e.g. isobutane with butylenes) at a temperature of —20° F. to +20° F. in the presence of a catalyst solution formed from H_2SO_4 of 96-98 percent strength and a small proportion of an aliphatic sulfate containing alkyl groups of 1-3 C atoms. This additive depresses the freezing point of the acid.

U.S.P. 2,468,899. Alkylation of Hydrocarbons. C. M. Thacker to the Pure Oil Company.

A mixture of paraffins, having at least 3 C atoms, with olefins is subjected to temperatures of 750-1100° F. at pressures in excess of 500 psi. in the presence of small amounts of bromine and of CCl_4, CBr_4, $CHCl_3$, or $CHBr_3$. Alkylation is greatly accelerated by the presence of the combined promoter.

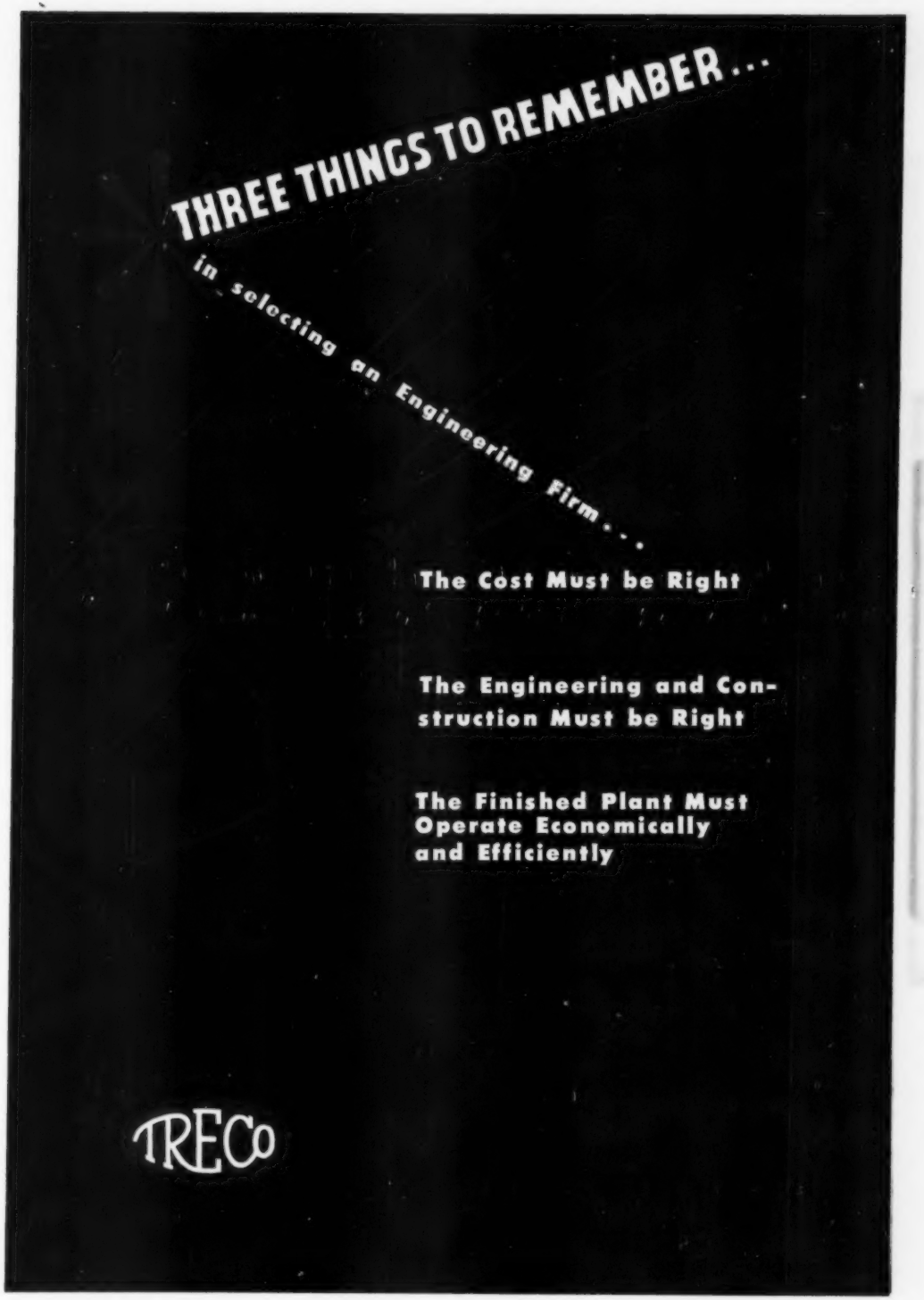
U.S.P. 2,469,335. Catalytic Alkylation. G. C. Johnson and B. W. Rope to Socony-Vacuum Oil Company, Inc.

An alkylatable hydrocarbon is contacted with an alkylating agent in the presence of a catalyst obtained by reacting mono- or di-fluophosphoric acid with BF_3.

U.S.P. 2,469,344. Homogeneous Gaseous Phase Catalytic Alkylation of Isobutane with Cyclopropane. W. A. Stover to Socony-Vacuum Oil Company, Inc.

An excess of isobutane is contacted with cyclopropane in gaseous phase at temperatures of 700-940° F. and pressures of at least 500 psi. in the presence of a halogen derivative of a hydrocarbon. High yields of triptane are obtained.

U.S.P. 2,469,823. Alkylation of Thio-


THREE THINGS TO REMEMBER...
in selecting an Engineering Firm...
The Cost Must be Right
The Engineering and Construction Must be Right
The Finished Plant Must Operate Economically and Efficiently
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phene. R. C. Hansford and P. D. Caesar to Socony-Vacuum Oil Company, Inc.

Thiophene or a thiophene derivative with at least one replacable hydrogen atom in the necleus is contacted with an alkylating agent in the presence of a BF_3 catalyst at a temperature of at least 20° C. for a time interdependent with the temperature and being at least 1.5 hours at 25° C. and varying with the activity of the alkylating agent.

ISOMERIZATION

U.S.P. 2,468,549. Hydrocarbon Conversion System. B. L. Evering and E. L. d'Ouville to Standard Oil Company of Indiana.

The details of a process are given for the isomerization of C_4 and C_5 paraffins by their passage with HCl through a reaction zone containing an $AlCl_3$ catalyst, a fixed gas containing H_2 and HCl being separated from the reaction product.

U.S.P. 2,468,746. Production of Improved Diesel Engine Fuels by the Catalytic Isomerization of High Boiling Paraffins. B. S. Greensfelder and R. J. Moore to Shell Development Company.

Straight chain paraffins with 10-16 C atoms are contacted with an aluminum halide-hydrocarbon complex catalyst in the presence of a saturated cyclic hydrocarbon at a temperature of 20-150° C. The ratio of the cyclic hydrocarbon to the paraffins is maintained at 2:1 to 8:1 parts by weight. Branched chain paraffins of about the same molecule weight are formed by the conversion of the straight chain paraffins. The product possesses a high ignition value and low pour point and forms a high quality Diesel engine fuel.

POLYMERIZATION AND CONVERSION

U.S.P. 2,466,694. Polymerization of Olefins in the Presence of Alkali and Alkaline Earth Metal Catalysts. W. V. Freed to E. I. du Pont de Nemours & Company.

At least two different normally gaseous open-chain monoolefin hydrocarbons with less than 10 C atoms are heated at a temperature of 275-400° C. under a pressure of 250-1000 atms. in the presence of an alkali or alkaline earth metal catalyst. A low molecule weight normally liquid open-chain monoolefin hydrocarbon with less than 10 C atoms formed by inter-condensation of the charge hydrocarbons is formed and separated. By the inter-condensation of ethylene and propylene, pentene is formed.

U.S.P. 2,467,231. Iodoso Diacylate Catalysis of Addition Polymerization Processes. L. M. Richards to E. I. de Pont de Nemours & Company.

An ethylenically unsaturated hydrocarbon containing only one ethylenic linkage, such as ethylene or styrene, is polymerized at a temperature of 0-100° C. in the presence of 0.1-10 percent of an iodoso diacylate catalyst.

U.S.P. 2,467,234. Preparation of Olefine

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Patents

Polymers. D. E. Sargent and W. E. Hanford to E. I. de Pont de Nemours & Company.

Ethylene is heated in tertiary butyl alcohol at 20-400° C. under a pressure 50-3000 atms. in the presence of 0.001-5 percent by weight of a peroxy compound catalyst, or the like. Solid polymers are obtained.

U.S.P. 2,467,245. Polymerization of Ethylene. G. M. Whitman and S. L. Scott to E. I. du Pont de Nemours & Company.

Ethylene is subjected in the presence of liquid anhydrous ammonia to a temperature of 150-300° C. under a pressure of 500-10,000 atms. in the presence of a metal catalyst of group II of the periodic table.

U.S.P. 2,467,382. Method of Forming Synthetic Elastomeric Butadiene Copolymers. C. H. Hempel to Heresite & Chemical Company

Specified proportions of butadiene and styrene or acrylonitrile are mixed in an aqueous medium in the presence of a small amount of alkali metal persulfate, alkali metal hydroxide and a cyclic symmetrical hydrocarbon inert to the reaction and containing 6 C atoms in the ring. The mixture is heated in a closed zone to a temperature of 36-40° C. until the self-generated pressure has dropped to zero.

U.S.P. 2,467,407. Catalytic Conversion of Fischer Synthesis Product. R. F. Ruthruff, Chicago.

Fischer synthesis product boiling above the usual motor fuel range and contaminated with oxygen compounds is converted into hydrocarbons of the usual motor fuel boiling range by contacting it at elevated temperature with a catalyst comprising a synthetic magnesium silicate containing up to 1 percent zeolitic sodium oxide.

U.S.P. 2,467,850. Apparatus for Catalytic Reactions. H. J. Ogorzaly to Standard Oil Development Company.

An apparatus for carrying out catalytic conversions of hydrocarbons is claimed. The stripping of the solid fluidized catalyst by a stripping gas is improved.

U.S.P. 2,467,966. Conversion of Hydrocarbons. A. Clark to Phillips Petroleum Company.

A fraction of C_4-C_6 hydrocarbons recovered from the reaction product of a Fischer-Tropsch synthesis is polymerized. The polymerization products are separated into different fractions. A fraction from the synthesis operation boiling in the gasoline range is isomerized to materials of higher octane rating. By further treating these and other of the products in a particular manner partly by hydrogenolysis, gasoline and Diesel fuel are obtained as the final products of the process.

U.S.P. 2,468,027. Emulsion Polymerization in the Presence of an Iron Salt and a Water-Soluble Peroxide. E. C. Britton and W. J. LeFevre to The Dow Chemical Company.

A monovinyl aromatic compound or an aliphatic conjugated dialefin is polymerized at a temperature of 50-150° C.

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in an emulsion having a pH of 1.5-3 in the presence of a water-soluble peroxide and an inorganic iron salt ionizable to form positive iron ions.

U.S.P. 2,468,111. Azodisulfonic Acid Salts as Polymerization Catalysts. J. A. Robertson to E. I. du Pont de Nemours & Company.

Ethylenically unsaturated organic compounds are polymerized in the presence of a catalyst consisting of a salt of azodisulfonic acid at a temperature below 100° C. Rapid polymerization is effected.

U.S.P. 2,468,177. Method of and Apparatus for Effecting the Electrochemical Transformation of Material in the Presence of Antenna Electrodes. W. J. Cotton to Koppers Company, Inc.

An apparatus and a method are claimed in detail which allow the electrochemical transformation of a gaseous material, such as a.o. polymerization, hydrogenation, dehydrogenation and oxidation of hydrocarbons.

U.S.P. 2,468,423. Dimerization of Butadiene. H. L. Johnson to Sun Oil Company.

Butadiene or methylated butadiene with one or two methyl groups is contacted at a temperature of 375-450° C. with silicon carbide. The corresponding dimerized product is formed.

U.S.P. 2,468,468. Apparatus for Conducting Reactions in the Presence of a Contact Mass. E. L. Sinclair and E. Utterback to Socony-Vacuum Oil Company, Inc.

The details of a reactor are claimed for contacting fluid reactants with a moving stream of a particle from solid contact mass. Distributing and collecting means are provided whereby fluid reactants may be conducted into the reactor or collected and conducted from the reactor in such a manner as to secure adequate and even distribution across the entire cross section of the reactor.

U.S.P. 2,468,507. Manufacture of Safety Fuel. F. J. Moore and E. F. Pevere to The Texas Company.

A C_4 hydrocarbon mixture containing butylenes, isobutylene and n-butane is freed from butane-2 and n-butane. The residual C_4 mixture is continuously passed to poylmerization in the presence of a H_2SO_4 catalyst (80 percent conclusive) at a temperature of about 140° F. and at a specified space velocity. The resulting product which contains a large proportion of hydrocarbons boiling at 300-400° F. is continuously withdrawn and employed as a safety fuel.

U.S.P. 2,468,508. Conversion Processes in the Presence of a Dense Turbulent Body of Finely Divided Solid Material. J. C. Munday to Standard Oil Development Company.

Hydrocarbons to be converted are passed upwardly through one portion of fluidized, turbulent bed of solid catalyst. A reactivating gas is passed upwardly through another and adjacent portion of this bed. Transfer of catalyst is permitted between these portions throughout the entire depth of the bed without any substantial mixing of the hydrocarbon and the reactivating gas. The method can also be used in the carrying out of gaseous reactions by means of two different gaseous streams, e.g. in oxidizing, reducing and chlorinating reactions.

U.S.P. 2,468,831. Reduction of Corrosive Action of Freidel-Crafts Type Catalysts. G. H. Miller to The Texas Company.

In the conversion (e.g. isomerization) of hydrocarbons at elevated pressure with an aluminum halide-hydrocarbon complex liquid corrosion of metal parts of the reaction zone is inhibited by contacting the complex catalyst before use in a separating zone in the absence of added hydrogen halide with finely divided free alkaline earth metal at elevated temperature and for a time sufficient to render the catalyst liquid relatively non-corrosive to boiler steel at 210° F.

U.S.P. 2,469,017. Method of Terminating the Polymerization of Butadiene-1, 3 Hydrocarbons. S. A. Sundet to The B. F. Goodrich Company.

In the emulsion polymerization of butadiene-1, 3 in the presence of a peroxygen compound an aqueous solution containing a compound of quinonoid structure, such as hydrochinone, a soluble inorganic sulfide or H_2S is added when 20-80 percent of the monomer is polymerized. Further polymerization is immediately terminated.

U.S.P. 2,469,329. Apparatus for Conducting Reactions in the Presence of a Solid Material. J. A. Crowley, Jr. to Socony-Vacuum Oil Company, Inc.

The details of an apparatus for catalytically converting hydrocarbons are claimed, wherein gaseous reactants may be contacted with a particle form solid for thermochemical conversion. The temperature of this solid is controlled between predetermined ranges throughout the reaction zone.

U.S.P. 2,469,332. Method for Conversion of Hydrocarbons. L. P. Evans to Socony-Vacuum Oil Company, Inc.

A high boiling hydrocarbon charge is heated to effect partial vaporization. The heated charge is flashed to separate the vapors from the liquid. The latter is passed through a conversion zone in contact with concurrently flowing, partially spent particle-form contact material introduced at an evelated conversion temperature. Lower boiling conversion products obtained are passed in the gaseous phase together with the vapors of the heated charge through a second zone in contact with freshly regenerated contact material charged at conversion temperature. Gaseous conversion products from the second zone are withdrawn and the hot partially spent contact material from the second zone is passed as the contact material to the first zone. Gasoline hydrocarbons are thus produced.

U.S.P. 2,470,065. Emulsion Polymerization of Butadienes. C. E. Barnes to General Aniline & Film Corporation.

Butadiene and styrene are copolymerized in aqueous emulsion in the presence of a catalyst, an emulsifying agent which is a water-soluble soap of a fatty acid with 12-18 C atoms, and of about 5-10 percent by volume of the total emulsion of an inert water-soluble organic solvent for the soap.

HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,464,539. Two-Stage Destructive Hydrogenation of Petroleum Oil. A. Voorhies, Jr. and E. T. Marshall to Standard Oil Development Company.

Petroleum oil is first subjected to destructive hydrogenation at elevated temperature and pressure in the presence of hydrogen and a catalyst consisting of a sulfide or an oxide of a metal of groups VI and VIII of the periodic system supported on a siliceous material which promotes cracking. Hydrogenated material boiling above gasoline is separated from the crude reaction product and subjected to a second destructive hydrogenation in the presence of a sulfur sensitive catalyst and a cracking catalyst under milder pressure and temperature conditions than employed in the first stage. Motor fuel of improved quality is recovered from both stages.

U.S.P. 2,465,235. Production of Hydrogen. N. F. Kubicek to Shell Development Company.

Hydrogen is produced by partial combustion of natural gas with oxygen, the CO produced being converted to CO_2 by the water-gas shift. The claims relate to particular improvements of this process.

U.S.P. 2,465,462. Catalytic Synthesis of Hydrocarbons. E. T. Layng to Hydrocarbon Research, Inc.

In the hydrocarbon synthesis from CO and H_2, the CO_2 obtained as a by-product is reacted with H_2 to generate methane and water vapor. The resulting methane is subjected to partial combustion with molecular oxygen in proportions effective to form CO-H_2 synthesis gas which is supplied to the hydrocarbon synthesis step.

U.S.P. 2,466,945. Generation of Synthesis Gas. F. C. Greene to In Situ Gases, Inc.

Synthesis gas is produced in situ from a geological formation having a deposit of combustible material therein by a method claimed in detail.

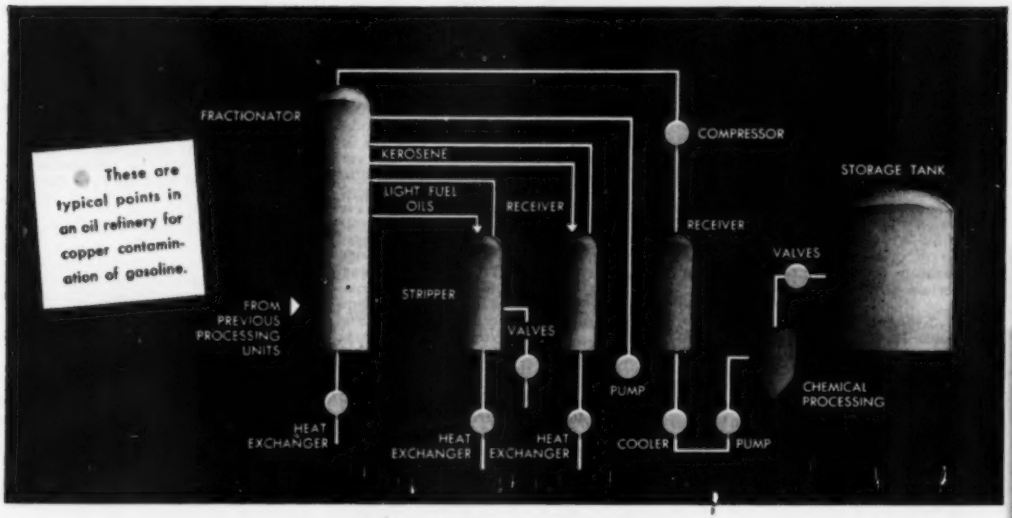
U.S.P. 2,467,282. Hydrocarbon Synthesis. B. R. Warner to Gulf Research & Development Company.

A mixture of CO and H_2 is passed, preferably at a temperature of 200-350° C., over a catalyst prepared by adding a water-soluble alkaline compound to an aqueous solution of a water-soluble iron salt to the point of incipient precipitation, then adding gallic acid to complete the precipitation, and recovering the precipitate.

U.S.P. 2,467,551. Production of Aromatics. E. Gorin and J. R. Vorwerck to Socony-Vacuum Oil Company, Inc.

A mixture of 85-60 parts by volume of dry natural gas with 15-40 parts by volume of chlorine or bromine is pyrolized at a temperature of 700-1000° C. The contact time is regulated so that substantially all halogen is converted to hydrogen halide. Liquid aromatic hydrocarbons are formed.

Do you realize the *many places* *Copper* can contaminate your gasoline?



To Control Copper Effectively Use Du Pont Metal Deactivator

Copper, always a potential source of trouble for the refiner, may be picked up from brass condensers, heat exchangers, valves, coolers, pumps, strainers, and other equipment. It only takes one part of copper in several million parts of gasoline to have a decided pro-oxidant effect and it is frequently hard to detect these traces by ordinary analytical methods.

The use of Du Pont Metal Deactivator offers an economical means for improving storage stability of gasoline containing copper. In every case overcoming the catalytic effect of copper is more economical with Metal Deactivator than an attempt at stabilization with anti-oxidants alone.

Deactivator effectivness may be readily determined by induction period tests. An increase in induction period with the addition of Metal Deactivator nearly always indicates the presence of copper.

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District Laboratories: Wilmington, Del.; Chicago, Ill.; Tulsa, Okla.; Houston, Texas; El Monte, Calif.

Patents

U.S.P. 2,467,802. Hydrocarbon Synthesis. F. T. Barr to Standard Oil Development Company.

A method of controlling catalyst activity in the hydrocarbon synthesis from CO and H_2 with the use of a fluidized catalyst is claimed. At least two separate conversion zones are employed in series, each stage being charged with catalyst withdrawn from a subsequent stage in the order of the flow of synthesis gas.

U.S.P. 2,467,803. Synthesis of Hydrocarbons. W. A. Herbst to Standard Oil Development Company.

The process of this patent is closely related to that of U. S. P. 2,467,802. A substantial reduction of carbon formation is accomplished by permitting CO-conversion of the fresh synthesis gas amounting to about 60-90 percent on a catalyst of originally high activity and carbonization tendency previously aged by a certain degree of CO-conversion.

U.S.P. 2,467,861. Synthesis of Hydrocarbons. W. G. Scharmann to Standard Oil Development Company.

CO and H_2 are contacted at synthesis conditions with a fluidized dense turbulent synthesis catalyst mass which prior to this contacting comprises a major proportion of active iron-type catalyst particles with low carbonization tendency and a minor proportion of the same type of catalyst with a strong carbonization tendency.

U.S.P. 2,467,919. Production of Cyclohexane. J. J. B. van Eijk van Voorthuysen and W. F. Engel to Shell Development Company.

Benzene is mixed with 1-5 mol parts methyl cyclohexane. The mixture is reacted in vapor phase at a pressure of between atmospheric and 400 atms. and at a temperature of 225-550° C. adjusted in accordance with the pressure to hydrogenate a substantial part of the benzene by hydrogen transfer. Cyclohexane is recovered from the reaction product.

U.S.P. 2,468,494. Hydrocarbon Synthesis. L. I. Griffin to Standard Oil Development Company.

In a Fischer-Tropsch synthesis process in the presence of a fluidized solid catalyst, a portion of this catalyst is withdrawn downwardly from the reaction zone under the pseudo-hydrostatic pressure of the catalyst. Gaseous and vaporous products and entrained catalyst are continuously withdrawn from the top of the reaction zone. Entrained catalyst is separated from the gases and vapors by an oil (e.g. gas oil or light lubricating oil). The withdrawn catalyst is contacted with liquefied normally gaseous hydrocarbon in a washing zone, into which the oil containing entrained catalyst is introduced. The catalyst is recovered from the washing zone and recycled.

U.S.P. 2,468,510. Pretreatment of Gases for the Synthesis of Hydrocarbons. J. J. Owen to Standard Oil Development Company.

A feed stock of impure CO and H_2 is contacted under suitable conditions with a solid desulfurization agent, such as copper carried on alumina or molybdenum, which does not form a metal carbonyl under these conditions. The purified feed gas is thereafter directly treated under hydrocarbon synthesis conditions in the presence of a fluidized synthesis catalyst while preventing the entry of desulfurizing agent into the synthesis zone.

U.S.P. 2,469,420. Dehydrogenation of Hydrocarbons. C. M. Thacker to The Pure Oil Company.

Hydrocarbons, such as ethane, propane or butane, are dehydrogenated at elevated temperature, e.g. 350-750° C., with a catalyst composed of activated alumina impregnated with beryllium oxide.

U.S.P. 2,469,755. Synthesis of Hydrocarbons from Carbon Monoxide and Hydrogen with an Iron Type Catalyst. A. Voorhies, Jr. to Standard Oil Development Company.

A catalyst for the Fischer-Tropsch synthesis consists of a reduced iron oxide shock-chilled from the molten state and a small amount of an alkali metal promoter. The new catalyst has high disintegration resistance.

DESULFURIZATION

U.S.P. 2,467,429. Treatment of Crude Petroleum. C. O. Hoover to Air Reduction Company, Inc.

Sulfur-containing crude petroleum is mixed with an oil-soluble cupric compound, such as cupric naphthenate, in amount such that the copper content is less than the atomic equivalent of the sulfur present. The mixture is heated to

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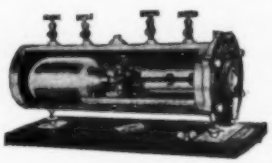

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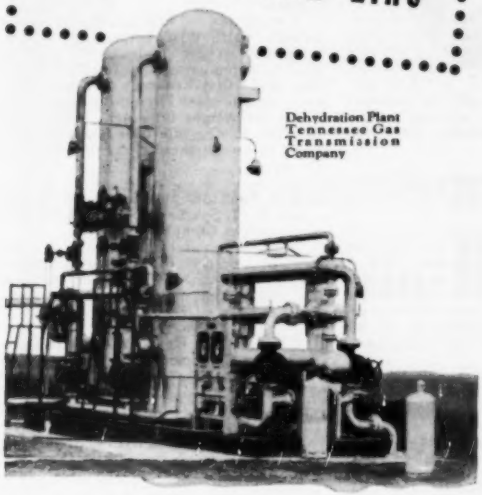

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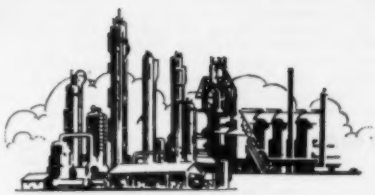

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temperatures necessary to effect distillation of volatile fractions but below the temperature at which substantial conversion of the sulfur compounds to CuS will take place (i.e. below 300° C.).

U.S.P. 2,469,726. Desulfurization of Tri-Isobutylene. W. G. Hockberger to Standard Oil Development Company.

S-containing crude tri-isobutylene is fractionated to form three fractions. The middle cut is percolated through 10-20 pounds of 28-200 mesh silica gel per barrel of tri-isobutylene. The sulfur is completely removed.

HEAVY OILS AND WAXES

U.S.P. 2,466,667. Core Oil and Core Compositions. C. L. Thomas to Universal Oil Products Company.

A core oil essentially consists of a mixture of a natural drying oil and a hydrocarbon fraction containing cyclic unsaturated hydrocarbons of specified characteristics, said fraction being obtained by reacting an olefin-containing charge in a particular manner.

U.S.P. 2,466,927. Lubricating Compositions. J. A. Burton to Graphol Products Company, Inc.

A lubricating composition for use in metal machining operations consists of 100-125 parts of a petroleum lubricating oil, 1-16 parts of turpentine oil, 1-5 parts of comminuted graphite, 1-2 parts of iron oxide and 1-5 parts of CCl_4.

U.S.P. 2,467,118. Complex from a Polyvalent Metal Petroleum Sulfonate, a Process of Making it and a Lubricating Oil Containing It. G. W. Duncan and J. C. Zimmer to Standard Oil Development Company.

A lubricating oil contains 0.1-5 percent of a complex compound formed between a polyvalent metal hydrocarbon sulfonate, e.g. calcium petroleum sulfonate and ammonium chloride or nitrate. The lubricant is useful for crank cases of internal combustion engines, promotes general engine cleanliness and reduces ring sticking and varnish formation.

U.S.P. 2,467,137. Metalworking Lubricant. H. L. Leland to Standard Oil Development Company.

A mineral lubricating oil is compounded with a sulfurized fatty oil in an amount sufficient to impart load-bearing properties to the mineral oil. The sulfurization of the fatty oil has been performed in the presence of 0.005-5 percent (based on the total composition) of a certain alkylated phenol. A transparent metal working oil is formed.

U.S.P. 2,467,145. Lubricant. A. J. Morway and J. C. Zimmer to Standard Oil Development Company

The solid lubricating grease consists essentially of 5-40 percent of acetylene black incorporated in a hydrocarbon-insoluble, inert fluorinated hydrocarbon mixture of 60-80 percent fluorine content by weight obtained by direct fluorination of a gas oil fraction

U.S.P. 2,467,176. Lubricant Addition Agents. J. C. Zimmer and G. W. Duncan to Standard Oil Development Company.

A mineral lubricating oil is compounded with a small amount of a product obtained by treating a mineral oil with an alkaline earth metal sulfonate in a particular manner.

U.S.P. 2,467,178. Penetrating Oil Composition. J. C. Zimmer and A. Beerbower to Standard Oil Development Company.

1-3 volumes of an aromatic hydrocarbon solvent with 6-9 C atoms are compounded with 3-1 volumes of an oily silicone polymer with a viscosity of 100-350 centistokes at 25° C. and 5-35 percent (based upon the total composition) of tricresylphospsate or -phosphite as an oiliness agent. A penetrating oil is obtained.

U.S.P. 2,467,713. Lubricating Oil Composition. F. M. Watkins to Sinclair Refining Company.

A petroleum lubricating oil fraction is compounded with a minor proportion of calcium iso-octyl salicylate and a mercapto olefin disulfide or the like. While the calcium additive is effective as a detergent, the sulfide additive inhibits corrosion and oxidation of the metal parts by the calcium of said additive.

U.S.P. 2,467,836. Lubricants. E. Lieber and M. M. Sadlon to Standard Oil Development Company.

A waxy mineral lubricating oil contains .02-2.0 percent each, of two additives. One works as a pour depressor and consists of a Friedel-Crafts condensation product of naphthene with chlorinated paraffin wax. The second additive, called a pour sensitizer, is obtained by amyl alcohol extraction of a material which is the same as or similar to the pour depressor.

U.S.P. 2,467,959. Manufacture of Refined Paraffin Wax. J. R. Bowman and W. P. Ridenour to Gulf Research & Development Company

A de-oiled wax is distilled into at least three fractions of different tensile strength characteristics. At least two of these fractions are combined in a particular manner to obtain different grades of valuable paraffin wax which have improved tensile strength.

U.S.P. 2,468,031. Lubricant. R. E. Burk and E. C. Hughes to The Standard Oil Company of Ohio.

A lubricating oil is compounded with ¼-3 percent of the reaction product of phosphorus sulfide on degras, and ½-3 percent of the reaction product of a salt of a metal from group VI, or the like, with an organic acid of low volatility, e.g. chromium naphthenate. This lubricant promotes combustion of deposits in the combustion zone of internal combustion engines and produces high stability in the crank-case.

U.S.P. 2,468,098. Grease Composition. A. J. Morway and C. R. Daniels to Standard Oil Development Company

The high melting grease consists of mineral oil thickened with a soda soap and 0.5-5 percent by weight of glycolic or lactic acid or mixtures thereof.

U.S.P. 2,468,099. High-Temperature Grease. A. J. Morway to Standard Oil Development Company.

A mineral base lubricating oil is thickened to grease consistency with a fatty material saponified by an alkali or alkaline earth metal hydroxide or oxide, or mixtures thereof, and containing an unsaturated aliphatic monobasic acidogenetic material with 3-4 C atoms, such as acrylic acid.

U.S.P. 2,468,501. Lubricating Oil Composition. E. Lieber and A. F. Cashman to Standard Oil Development Company.

A waxy mineral lubricating oil is compounded with 0.1-2 percent of a high molecular weight condensation product of chlorinated paraffin wax and naphthalene, and 0.01-1.5 percent of a polymeric compound prepared by pyrolyzing a high molecular weight fatty acid chloride at 400-750° F. The lubricant thus prepared flows at lower temepratures than its base stock.

U.S.P. 2,468,516. Lubricants. R. Rosen and W. J. Sparks to Standard Oil Development Company.

A waxy mineral lubricating oil contains 01-2 percent of a chlorinated polyvinyl oleyl ether with 10-25 percent chlorine content and an average molecular weight of 12,000.

U.S.P. 2,468,520. Extreme Pressure Lubricating Compositions. L. W. Sproule and L. F. King to Standard Oil Development Company.

A lubricating composition consists of 70-95 parts by weight of mineral oil, 1-15 parts of a halogenated hydrocarbon wax, and 1-20 parts of the reaction product of 60-100 parts of sperm oil, 10-30 parts of sulfur, and ½-2 parts of phosphorus sulfide subjected to a temperature of 250-450° F. for ½-12 hours. The composition is particularly suited for use under extreme pressure conditions.

U.S.P. 2,469,003. Lubricating Oil Compositions. A. G. Rocchini to Gulf Research & Development Company.

A lubricating hydrocarbon oil is compounded with 0.1-5 percent by weight of the composition of an oil-soluble polyvalent metal salt of naphthenoxy-stearic acid. Metals of groups II and VIII of the periodic system are preferably used therein, e.g. nickel naphthenoxy-stearate. The lubricant has improved detergent property and oxidation stability.

U.S.P. 2,469,041. Methods for Preparing Aluminum Soaps and Certain Classes of Useful Compositions Containing Aluminum Soaps. N. L. Jones to Standard-Vacuum Oil Company.

A higher fatty acid is added to a solution of aluminum alkoxide in a hydrocarbon lubricating oil to convert the alkoxide to an aluminum soap and release alcohol. After cooling to normal temperature the resulting fluid lubricant is converted to a grease by the addition of a small amount of moisture.

U.S.P. 2,469,469. Oxidation Inhibitors. H. D. Kluge and E. C. Knowles to The Texas Company.

A lubricating mineral oil is compounded with 0.01-3 percent by weight of a 4-halogeno-2,6-di-tertiary alkyl phenol. The additive inhibits oxidation of the lubricant.

U.S.P. 2,469,725. Synthetic Lubrication

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Patents

Oil Production. R. L. Heinrich to Standard Oil Development Company.

From a first mixture containing alpha and beta olefins and alpha tertiary olefins is separated a second mixture of alpha mono-olefins and alpha tertiary olefins. This second mixture is subjected to catalytic polymerization. A polymer in the lubricating oil boiling range is obtained.

PETROCHEMICALS

U.S.P. 2,464,572. Production of Nitroparaffins. K. W. Gee to Imperial Chemical Industries, Ltd.

A catalyst consisting of pure metallic aluminum in fragmentary form is treated at elevated temperature with gaseous nitrogen peroxide. A mixture of at least one paraffin hydrocarbon and nitrogen peroxide is then heated in the gaseous phase in the presence of the pre-treated catalyst. Nitroparaffins are produced. The activity of the catalyst is improved by the pre-treatment.

U.S.P. 2,464,723. Preparation of Unsaturated Nitriles. W. A. Schulze and J. E. Mahan to Phillips Petroleum Company.

Details of a continuous process are claimed for the production of unsaturated nitriles by interaction of conjugated diolefins with not more than 6 C atoms and HCN.

U.S.P. 2,464,916. Oxo Process. C. E. Adams and D. E. Burney to Standard Oil Company (Indiana.)

An olefin is treated with CO and H_2 at elevated temperature and pressure in the presence of a Co- or Fe-catalyst and the resulting aldehyde is hydrogenated to form the corresponding alcohol. Details of the process are claimed.

U.S.P. 2,465,318. Polymerization Products of Piperylene and its Methyl Homologues, and Unsaturated Nitriles. R. B. Seymour to Monsanto Chemical Company.

A monomeric mixture of piperylene or a monomethyl homologue thereof with 5-50 percent of a nitrile of the structure:

$$R-\underset{\displaystyle R_1}{\underset{|}{C}}=\underset{\displaystyle R_2}{\underset{|}{C}}-CN$$

where R is phenyl or CN and R_1 and R_2 are either H, an alkyl group of 1-8 C atoms, a halogen, phenyl, CN, or CO_2-alkyl, is heated to a temperature of 25-100° C. A colorless, transparent, moldable thermoplast is obtained which possesses high impact strength.

U.S.P. 2,465,900. Fluorinated Dialkylbenzenes. E. T. McBee and O. R. Pierce to Purdue Research Foundation.

The side chains of p-cymene, or the like, are photochemically chlorinated, and the chlorine is subsequently replaced by fluorine in such a manner that the number of F atoms in the methyl group is 3 and that in the isopropyl group is 1-7.

U.S.P. 2,465,960. Production of Asphalt Composition. J. van den Berge to Shell Development Company.

Mineral oil asphaltic bitumen is sub-

jected to a temperature of 100-450° C. in the presence of a minor proportion of a polynitrophenol. Asphaltic bituminous compositions are obtained.

U.S.P. 2,465,984. Production of Cycloalkyl Nitrites. T. F. Doumani, C. S. Coe and E. C. Attané, Jr. to Union Oil Company of California.

Cycloalkyl nitrites are produced by dissolving a minor proportion of nitrogen tetroxide (N_2O_4) in a cycloalkane, such as cyclopentane or -hexane, and heating the resulting solution in the liquid phase.

U.S.P. 2,466,189. Process for Adding Fluorine to Acylic Olefinic Compounds. T. P. Waalkes to E. I. du Pont de Nemours & Company.

Olefins are mixed at a temperature below 0° C. with an excess of HF and PbO_2. The temperature is then raised to reaction temperature after closing the reaction vessel. Fluorine addition products are obtained.

U.S.P. 2,466,617. Method for Producing Acetylene. O. Spring to Danciger Oil & Refining Company.

Streams of hydrocarbons and preheated air are concurrently passed to a reaction zone and homogeneously and instantaneously mixed as they enter this zone by subdividing the hydrocarbon stream into a series of streamlets of small cross-section at the point of contact with the entire heated air stream. This admixture raises the temperature instantaneously to the reaction temperature. Acetylene formed is recovered.

U.S.P. 2,467,013. Process for the Manufacture of Vinyl Chloride. A. J. D. H. M. de Vaissière to Soc Anon. des Manufactures des Glaces et Produits Chimiques de St. Gobain, Channy & Cirey.

A mixture of acetylene and HCl is passed over a mercuric vanadate catalyst at a temperature of about 100° C. Vinyl chloride is produced.

U.S.P. 2,467,206. Preparation of Aryl Esters. W. F. Gresham and R. E. Brooks to E I. du Pont de Nemours & Company.

An olefinic hydrocarbon, such as ethylene, isobutylene or propylene, is heated with CO and a phenol at a temperature of 150-500° C. under a pressure of 50-3000 atms. in the presence of a Ni or Co catalyst and in the absence of an inorganic acidic catalyst. Esters produced by the reaction between the three different types of components are separated.

U.S.P. 2,467,339. Vinyl Aromatic Compositions Containing Colloidal Silica. R. B. Seymour to Monsanto Chemical Company.

An aqueous polystyrene emulsion is mixed with a silica aquasol. The mixture is dried and a polystyrene product is recovered which contains 2-70 percent of silica. Upon dissolving the product in a solvent for polystyrene, the silica remains inseparable. The product is resinlike.

U.S.P. 2,467,993. Manufacture of Formaldehyde and Apparatus Therefor. R. P. Rossman to Godfrey L. Cabot, Inc.

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A mixture of methane, air and nitrogen oxides is passed through a continuous tubular reactor at atmospheric pressure, first in contact with metal at a temperature below 1100° F. and then immediately in contact with silica at a higher temperature. On condensing the gaseous product, formaldehyde is recovered.

U.S.P. 2,468,054. Copolymers of Vinylidene Fluoride with Ethylene and Halogenated Ethylenes. T. A. Ford to E. I. du Pont de Nemours & Company.

A mixture of 5-95 percent ethylene and 95-5 percent vinylidene fluoride is polymerized in the presence of a peroxide catalyst at a pressure in excess of 10 atms.

U.S.P. 2,468,363. Methods for Preparing Acetonitrile. J. L. M. Fréjacques to Comp. de Produits Chimique et Electrometallurgiques Alais, Froges et Camargue.

A mixture of ammonia and acetylene is successively passed through two furnaces containing a compound catalyzer comprising ZnO, Al_2O_3 and Cr_2O_3 and a small amount of an alkaline substance. The acetonitrile formed is condensed from the effluent at the outlet of each furnace.

U.S.P. 2,468,522. Production of Nitriles. J. W. Teter to Sinclair Refining Company.

A mixture of olefin and an excess of ammonia is contacted with a catalyst consisting of reduced cobalt or nickel oxide on a titanium dioxide carrier at a temperature of 400-725° F. and a pressure of about 1500 psi. Nitriles are produced.

U.S.P. 2,468,523. Delayed-Action Polymerization Process. R. M. Thomas, D. W. Young and J. D. Calfee to Standard Oil Development Company.

A mixture of a major proportion of isobutylene and a minor proportion of a polyolefin with 4-14 C atoms, e.g. butadiene or isoprene, is cooled to a temperature of —40 to —160° C. A catalyst comprising a double salt of $AlBr_3$ and aluminyl bromide dissolved in butane is stirred into the cooled mixture during an induction period. A triggering catalyst comprising a portion of $AlCl_3$ dissolved in ethyl chloride is thereafter added. High-grade rubber substitutes are obtained.

U.S.P. 2,468,739. Condensation of Olefinic Compounds with Hydrogen Sulfide. J. L. Eaton and J. B. Fenn to Sharples Chemicals, Inc.

A tertiary olefin with 8-24 C atoms is condensed below 0° C. with H_2S in the presence of a suitable catalyst, such as BF_3. The catalyst is deactivated after the reaction by means of an aqueous quenching agent, such as aqueous methanol, at a temperature below 0° C.

U.S.P. 2,468,747. Interpolymers of Drying Oils, Mono-Alkenyl-Aromatic Hydrocarbons, and Divinylbenzene. G. A. Griess and A. S. Teot to The Dow Chemical Company.

A drying oil having less than 35 percent of its olefinic linkages conjugated is interpolymerized in the absence of solvents with certain amounts of a mono-alkenyl-aromatic hydrocarbon material wherein each mono-alkenyl-aromatic component contains 8-10 C atoms, particularly styrene, and of divinyl benzene under specified conditions. A clear varnish resin readily soluble in toluene is formed.

U.S.P. 2,468,748. Drying Oil-Styrene Interpolymers. G. A. Griess and A. S. Teot to The Dow Chemical Company.

The process of this patent is related to that of U. S. P. 2,468,747. A mixture of a monovinyl aromatic compound, such as styrene, and an alpha-methylene alkyl aromatic compound, such as alpha-methyl styrene, is here interpolymerized with the drying oil.

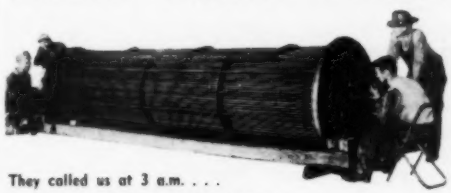
U.S.P. 2,468,759. Chemical Process. R. Johnson to Koppers Company, Inc.

Ethyl naphthalene is treated with oxygen in the presence of an oxidation catalyst at a reactive temperature below that at which dehydration of methyl naphthyl carbinol occurs. A mixture of this compound and methyl naphthyl ketone is obtained. This mixture is treated with hydrogen in the presence of a hydrogenation catalyst at a corresponding reactive temperature. The ketone of the mixture is thus reduced to the carbinol. The methyl naphthyl carbinol is thereafter thermally dehydrated to produce vinyl naphthalene.

U.S.P. 2,468,770. Rosin-Styrene Interpolymers. E. D. Morris and G. A. Griess to The Dow Chemical Company.

The process of this patent is related to that of U. S. P. 2,468,748. Rosin is here

RUSH! RUSH! RUSH!



They called us at 3 a.m. . . . plant was down . . . reboiler needed retubing . . . must get on stream fast! Our truck left one hour later. At noon our men started the job . . . worked three shifts daily to fast completion . . . and delivered to a new, satisfied customer.

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Fractionating Towers
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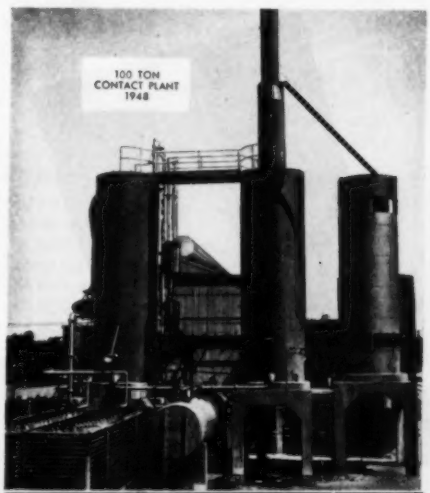

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SULPHURIC ACID
ACID-RECOVERY
PLANTS and
DESIGNS

NICOLAY TITLESTAD
CORPORATION
11 West 42nd St., New York 18, N. Y.

Patents

employed instead of the drying oil. A varnish resin is obtained also in this case.

U.S.P. 2,468,822. Production of Hydrocarbon Resins. W. K. Griesinger to The Atlantic Refining Company.

An unsaturated hydrocarbon distillate boiling at 300-600° F. under 10 mm. pressure and derived from hydrocarbon polymers resulting from the treatment of cracked gasoline with a polymerizing adsorbent is contacted with an equal volume of H_2SO_4 of 90-100 percent conc. for ¼-3 hours at a temperature of 30-50° F. An acid layer obtained which contains unsaturated hydrocarbons is diluted with an equal volume of water. An insoluble oily layer formed is separated from the acid layer, neutralized and heated at a temperature of about 200° F. until solidification to a hard, brittle resin is effected, which can be used for coating and impregnating purposes, etc.

U.S.P. 2,468,904. Production of Carbon Bisulfide. C. R. Wagner to Phillips Petroleum Company.

A hydrocarbon is reacted with H_2S and SO_3 in the gaseous state at a temperature of 300-500° C. in the presence of a catalyst, e.g. a silica-alumina catalyst. Carbon bisulfide is recovered. A H_2S-containing sour natural gas, or the like, can be employed in this process.

U.S.P. 2,469,132. Manufacture of Sulfur Compounds. W. A. Schulze and W. W. Crouch to Phillips Petroleum Company.

An aqueous emulsion of certain proportions of conjugated butadiene, styrene and an aliphatic mercaptan with 10-16 C atoms and a single SH group is subjected to polymerizing conditions in the presence of an oxidizing polymerization catalyst. Unsaturated sulfur-containing liquid or semi-solid compounds are produced which are useful as plasticizers, adhesives, drying oils, etc.

U.S.P. 2,469,326. Interpolymerization of Thiophene and Butadiene. P. D. Caesar and A. N. Sachanen to Socony-Vacuum Oil Company, Inc.

Thiophene, a monoalkyl thiophene or a dialkyl thiophene with low alkyl substituent is contacted with butadiene-1,3 in a mol. proportion of 1-3:3-1 in the presence of H_2SO_4 in amounts to produce a concentration of H_2SO_4 in the system varying between 5 percent and 100 percent based on the total weight of the thiophene reactant and butadiene-1,3 in the charge, and for a period sufficient to effect resinification.

U.S.P. 2,469,334. Haloalkylation of Aromatic Hydrocarbons. H. D. Hartough and P. K. Chung to Socony-Vacuum Oil Company, Inc.

A liquid aromatic hydrocarbon fraction is intimately contacted with an aqueous aldehyde, e.g. formaldehyde, and with an aqueous hydrogen halide in the presence of a contact material consisting of a solid, highly porous adsorptive material presenting a relatively large surface area of contact to the reactants. The haloalkylated aromatic compound produced is separated from the reaction mixture, the remainder of which is recycled in the continuous process.

U.S.P. 2,469,702. Production of Alkyl Halides. C. C. Schwegler and F. M. Tennant to The Dow Chemical Company.

An olefin and a hydrogen halide are passed into a mixture of a catalyst containing $AlCl_3$, $AlBr_3$, $FeCl_3$ or $FeBr_3$, and a non-reactive organic liquid of boiling point at least as high as that of the alkyl halide thus formed. Foaming during the reaction is curtailed by the addition of a minor amount of sulfur to the reaction mixture.

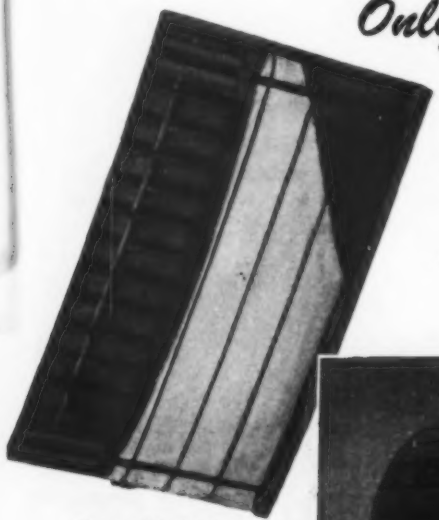
U.S.P. 2,469,788. Polymerization Products and Process of Making Same. J. B. Rust to Montclair Research Company.

A mixture of isobutylene, or another isoolefin, and isopropenyl methyl ketone, or a similar unsaturated ketone, is polymerized in the presence of a Friedel-Crafts catalyst at a temperature of 0° to —100° C. The ratio of isoolefin to ketone can be from 10:1 to 10:5 by weight. A high molecular weight extensible copolymer is obtained.

U.S.P. 2,469,833. Copolymers of Butadiene and Alkyl Esters of Alpha, Beta Dichloroacrylic Acid. J. G. Lichty to Wingfoot Corporation.

A mixture of 10-90 percent butadiene-1,3 and 90-10 percent of an alkyl ester of alpha, beta-dichloroacrylic acid is copolymerized.

Only GB **FILTERS** *have "It"*



"It" is the G-B patented drum compartment drainage shown in the close-up at left. From the rugged, precision machined division bars to the die-formed wire and locking strips, G-B drainage was designed to provide

1. **Smooth, uniform support for maximum cloth life**
2. **Easy cloth replacement and drainage screen renewal**

These features help you obtain

LOW MAINTENANCE COST
GREATER TIME ON STREAM

For complete details on G-B Filters, write

GOSLIN-BIRMINGHAM
MANUFACTURING COMPANY, Inc.
Birmingham, Alabama
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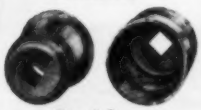
McDowell

STEEL THREAD PROTECTORS...

Tool Joint Protectors

Special Casing Protectors



Special Tubing Protectors

McDowell Steel Thread Protectors provide maximum protection for your tubing, tool joints, drill pipe or casing, either in shipping, storage, field use or handling.

Drill Pipe Protector

Threads and sizes are accurate and uniform, which make for easier, faster on or off operations.

McDOWELL
MANUFACTURING COMPANY
PITTSBURGH 9, PENNA.

NOW!
FLEXIBLE PLASTIC TERMINAL INSULATION
AMPsulation
MOULDED TO ORDER!

The use of plastic moulded terminal insulation gives unusual flexibility and other design advantages inherent in a moulded piece. These may involve color, size, or shape, as the cross section of the moulded sheath can be made to order.

Superior to rubber, this plastic has higher dielectric properties, "live" flexibility, and low shrinkage. Not affected by oil, grease, age, sunlight, or temperatures up to 170° F., the material is practically irremovable. A large selection of opaque colors are available for special coding or matching.

The AMPsulation process is for use in the mass production of "leads." AMP applies the plastic insulation, by its special methods, to pre-crimped terminals. Any AMP terminal or connector of any tongue size or shape can be used, whether applied by hand, power presses, or automatic machine. AMPsulation process can be suited to almost any lead you may be using, or contemplate using.

Further information concerning AMPsulation can be had by sending samples of wire and lead specifications. Complete details of any of the complete line of Solderless Wiring Devices, PRE-INSULATED terminals, automatic machines, or tools, can also be had by writing to:

UNLIMITED DESIGN POSSIBILITIES
Here, for example, the grommet has become an integral part of the terminal's insulation.

Here the moulded insulation serves as a seal from dirt, atmosphere, or vibration.

AMP AIRCRAFT-MARINE PRODUCTS Inc.
1022 N. FOURTH STREET, HARRISBURG, PA.
Sole Canadian representative:
P. MALLEY & SONS LTD., Toronto, Ont., Canada

For Sale
ALL NEW
REFINERY EQUIPMENT
IMMEDIATE DELIVERY

TOWERS —
1 — Crude Synthetic Tower, 7' 6" I.D. x 85' 7" High (Item 9)
1 — Salt Neutralizer Tower, 24' High (Item 47)
1 — Stripping Tower, 5' I.D., 28' High (Item 1075S)
2 — Absorption Towers, 8' I.D., 34' High (Item 1076S)
1 — Scrubbing Tower, 8' I.D., 23' High (Item 1077S)

TANKS —
2 — Salt Storage & Pump Tanks 12' O.D., 60' Long (Item 8-546)
1 — Depropanizer Feed Surge Tank, 8' O.D., 14' Long (Item 524)

PUMPS —
2 — Molten Salt Pumps, vertical, Ingersoll-Rand size 32, cap. — 9000 GPM (Item 25)
2 — Molten Salt Pumps, vertical, Ingersoll-Rand size 40, cap. — 17,500 GPM (Item 24)
14 — Reciprocating Pumps:—(Item 341)
2 — 8 x 5 x 12 — Cap. 30 GPM
2 — 6 x 6 x 18 — Cap. 51 GPM
1 — 12 x 7 x 18 — Cap. 190 GPM
1 — 6 x 7¼ x 12 — Cap. 75 GPM
2 — 6 x 5 x 12 — Cap. 35 GPM
2 — 6 x 4 x 6 — Cap. 15 GPM
2 — 10 x 6 x 12 — Cap. 35 GPM
1 — 6 x 3¾ x 6 — Cap. 26 GPM
1 — 5¼ x 4¾ x 5 — Cap. 32 GPM

TURBINES —

1 — 925 HP Terry	1 — 20 HP Terry
1 — 750 HP Terry	1 — 15 HP Terry
1 — 150 HP Terry	1 — 15 HP G.E.
1 — 65 HP G.E.	1 — 9 HP Terry
1 — 55 HP Terry	1 — 9 HP G.E.
1 — 50 HP G.E.	1 — 5 HP Terry
2 — 24 HP Terry	1 — 2 HP G.E.

VALVES —
147 MOTOR OPERATED VALVES — 3" to 18", Incl.

ALSO AVAILABLE —

ELECTRIC MOTORS	INSTRUMENTS
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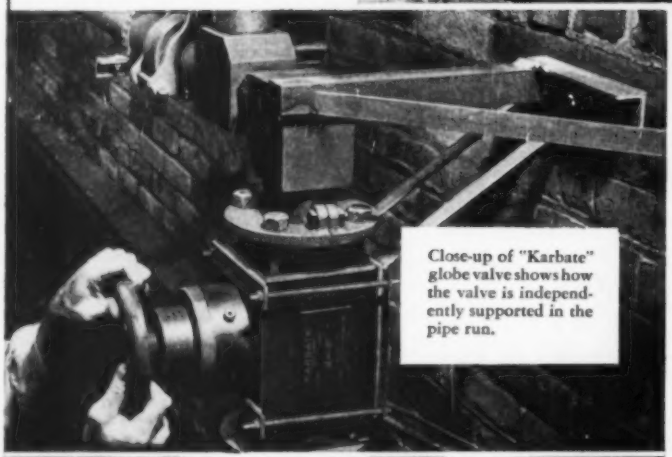
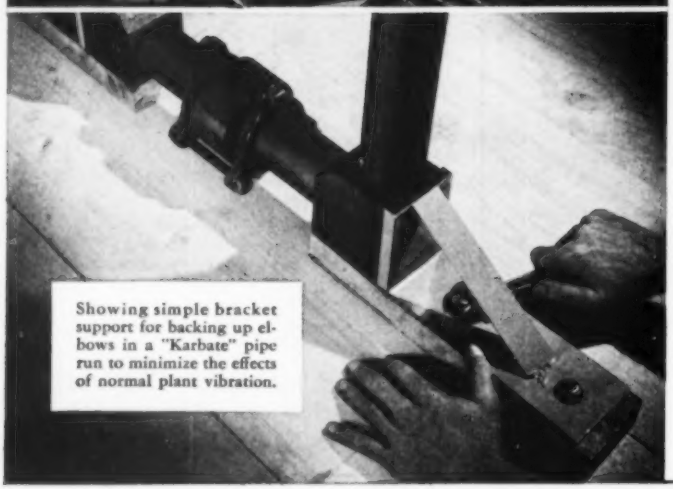
How to support a "Karbate" pipe line.

A correctly supported "Karbate" pipe run. Note elimination of strain with the simple, rigid angle iron brackets and braces providing uniform load support.



Close-up of "Karbate" globe valve shows how the valve is independently supported in the pipe run.



Showing simple bracket support for backing up elbows in a "Karbate" pipe run to minimize the effects of normal plant vibration.

KEEP "KARBATE" PIPE ALWAYS IN STOCK

- Resists the action of acids, alkalies and other chemicals
- Light weight with adequate strength
- Resistant to mechanical shock
- Immune to thermal shock
- Easy to machine and install
- Full range of sizes and fittings

Write for Installation Manual M-8801 A. Address Dept. PR.

•

The term "Karbate" is a registered trade-mark of

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

UCC

30 East 42nd St., New York 17, N. Y.

Division Sales Offices:
Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

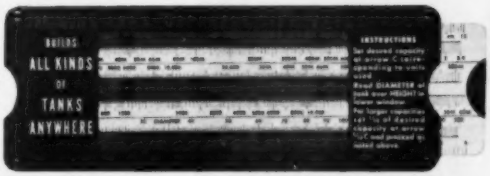
Foreign Department—New York, U.S.A.

These products sold in Canada by Canadian National Carbon Co., Ltd., Toronto 4, Canada

NEW EQUIPMENT and Manufacturers' Literature

For copies of manufacturers' literature or more information on products described on these pages write to the address shown, using the number shown for each item.

Slide Rule Type Calculator (Item 318)



Hammond Iron Works of Pennsylvania and Texas have developed a slide rule type calculator to show storage capacity in gallons and cubic feet in tanks of from 10 to 100 feet in height and from 20 to 120 feet in diameter. Also included on the calculator are weights of steel plate; fractions and decimal equivalents from 1/8 of an inch to 11 7/8 inches; and equivalent measurements of gallons, cubic feet and barrels with their weights in water.

A tank-capacity calculator may be obtained by writing Hammond Iron Works, 630 Fifth Avenue, New York City 20, referring by number to this PETROLEUM REFINER item 318.

All-Purpose Hose (Item 319)

Ortac, the new all-purpose hose of Goodyear Tire & Rubber Company, is "capable of carrying air, water, oil, gasoline and acids of low concentration and temperature." It is made with virtically braided rayon carcass and oil-resisting synthetic tube, friction and cover. Sizes range from 3/16-inch to 1½-inch inside diameter.

For further information write Goodyear Tire & Rubber Company, Akron, Ohio, referring to PETROLUEM REFINER item 319.

Pipe Saw (Item 320)

Cast iron or steel pipe from 12 to 48 inches in diameter can be cut "at the rate of 2 inches per minute" by the new air-powered pipe saw introduced by The E. H. Wachs Company. The machine uses a high speed steel cutter which "leaves a milled edge, making the cut in one complete rotation." It requires 85 pounds of air pressure for operation. Silent type chains strap the saw to the pipe and act as a flexible ring gear for positive feed. Cuts may be made under water, above ground or under ground, the machine requiring a 14-inch clearance for the latter. Adjustment changes are made by setting guide rollers and altering the chain lengths.

For further information write The E. H. Wachs Company, 1925 North Dayton Street, Chicago 22, referring to PETROLEUM REFINER item 320.

Ultra-Microburet (Item 321)

Based on the displacement principle, The Gilmont ultra-microburet presented by Emil Greiner Company, is capable of "rapid titration with complete elimination of nerve-racking manipulation." Microburets are available for total displacements of 1 ml. (in 1/1000 ml.) or 0.01 ml. (in 1/1000 ml.). Accuracy of 0.03 percent of total displacement is claimed. Other features are rubber protection, capillary tube, silicone rubber gasket and seat, precision ground plunger, and precision micrometer dial gauge.

For further information write The Emil Greiner Company, 20-26 Moore Street, New York City, referring by number to this PETROLEUM REFINER item 321.

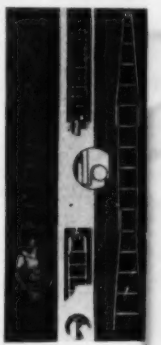
All-Chemical Additive (Item 322)

American Cyanamid Company has available Aerolube 70, an all-chemical additive for crank case lubricants, claimed to be an oxidation and bearing corrosion inhibitor, to permit closer manufacturing of finished motor oil, to be soluble in oil and to have stability and compatibility with other additives.

For further information write American Cyanamid Company, 30 Rockefeller Plaza, New York 20, referring by number to this PETROLEUM REFINER item 322.

Aluminum Ladders (Item 323)

Zero-Lite Products has developed a new line of aluminum ladders in sizes from 6 to 20 feet in straight ladders, 16 to 40 feet in extension ladders, 4 and 6 foot sections on window cleaner's ladders and 4 foot sections for estimator's ladders. Rounded at top, they have insert rubber feet at the bottom. They may also be slotted for safety shoes. Rungs are ribbed and joints have no rivets, bolts or welds.



For further information write Department 295, Zero-Lite Products, 317 Sherman Street, Chicago, referring to PETROLEUM REFINER item 323.

Boiler Feed Pumps (Item 324)

Barrel-type pumps for high pressure boiler feed service have been developed by De Laval Steam Turbine Company. The barrel-type diffuser vane pumps are 7-stage units designed for 835 gpm. at 1800 psi., driven by 1250-hp., 300-rpm. squirrel cage motors through variable speed, fluid couplings. An "A" frame with a monorail trolley is furnished as part of the pump assembly.

For further information write De Laval Steam Turbine Company, Trenton 2, N. J., referring by number to this PETROLEUM REFINER item 324.

Flexible Abrasive (Item 325)

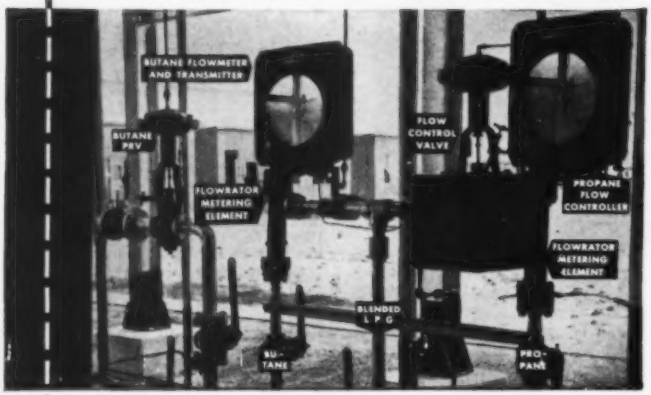
When held against a turning commutator, a flexible abrasive of Ideal Indus-

LPG BLENDED MORE PROFITABLY AND MORE UNIFORMLY

through simplified

straight-line accuracy

flow control



The F & P RATIO CONTROLLER blends overhead products from depropanizer and debutanizer columns to exact vapor pressure specifications. It's no longer necessary to change tower operation when vapor pressure specs are altered; you simply turn a knob in the RATIO CONTROLLER to get any blend ratio between 90% C3 - 10% C4 and 10% C3 - 90% C4.

The flow of butane is accurately measured by a FLOWRATOR meter-transmitter. This resets the control point on a similar FLOWRATOR instrument which controls the amount of propane put into the LPG mixture.

Here are a few of the "plus" features of the F & P RATIO CONTROLLER:

1) They record butane and propane flows; valuable operating records are produced without additional flowmeters. 2) Their flow scales are uniformly spaced; peak accuracy is assured over the entire range of flow measurement. 3) They are free of electrical connections; safe in hazardous areas. 4) They require no "meter runs"; installation cost are low. 5) There is just one moving part, free of packing glands; maintenance costs are negligible.

For detailed engineering information write for Bulletin 53.

FISCHER & PORTER CO.
DEPT. 9S-1C HATBORO, PA.

FLOWRATOR
TRADE MARK

INSTRUMENTS FOR FLOW MEASUREMENT AND AUTOMATIC CONTROL

tries, Inc., removes high resistance film, dirt, grease, tool marks, scratches and rust from copper, brass, bronze, iron, steel, aluminum and other metals. The abrasive consists of a fine grain material held together by a flexible bond and molded in stick form. It is available in five sizes, from ⅜" by ½" by 5" to 1" by 4" by 5".

For further information write Ideal Industries, Inc., 1531 Park Avenue, Sycamore, Ill., referring by number to this PETROLEUM REFINER item 325.

Safety Relief Valve (Item 326)

Farris Engineering Corporation has manufactured a nozzle type safety-relief valve designed with an 8-inch inlet and 10-inch outlet. The 975-pound valve has an orifice diameter of 5 inches and a top pressure of 300 pounds. It is API and ASME coded and has a certified lift of ¼ of diameter of nozzle. Round wire springs, small diameter piston guide, and a complete baffle are other features. The valve is equipped with an alignment spool providing alignment and bearing from stem to disc. Drain is directed downstream to relieve chamber pressure.

An expanding orifice increases on lift, while a single blowdown ring does not affect its capacity.

For further information write Farris Engineering Corporation, 484 Commercial Avenue, Palisades Park, N. J., referring by number to this PETROLEUM REFINER item 326.

Air, Liquid Dryers (Item 327)

Catalog D-27 of C. M. Kemp Manufacturing Company features a discussion of the general operation of a dryer for the desiccant-bed drying of air, gases and liquids. It also explains the basic principles and specific factors affecting the dynamic drying of air, compressed air, gaseous ammonia, nitrogen, metallurgical atmospheres (heat treating), hydrogen, inert gases, natural gas, oxygen and liquids including animal oils, butane, distillate fuel oil, freon, gasoline, vegetable oils and others. Cut-

away drawings, diagrams, etc., describe the Kemp products which provides a source of dried air in moderate amounts for actuating tools, valves, instruments.

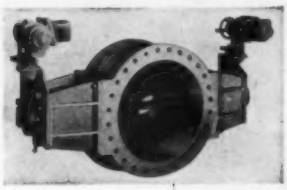
For a copy write Kemp Manufacturing Company, 405 East Oliver Street, Baltimore 2, referring by number to this PETROLEUM REFINER item 327.

Magnesium Anode (Item 328)

The Rustonode, a magnesium anode that offers cathodic protection against rust scaling on condenser heads, dividers and tube sheets is offered by Cathodic Protection Service. The anode is designed to supplement water treating for protective results and may be used as a means of corrosion prevention in condenser heads. It is designed to protect only the walls of the chamber within which it is placed and may be used within both fixed and floating heads. A plastic shielded mount allows all of the current flow to be directed to useful protection, with little loss due to overprotection of immediate surfaces.

For further information write Cathodic Protection Service, Niels Esperson Building, Houston, referring by number to this PETROLEUM REFINER item 328.

Electric Dual Valve (Item 329)



R-S Products Corporation has developed a 36-inch by 8-inch 150-pound class B steel dual valve (type No. 725) for an operating temperature of 1000° F. Powered by separate electric motors, each alloy steel vane is operated independently of the others, "insuring close control of volume and pressure." It is designed for either a high pressure drop and a small volume or a low pressure drop and a large volume.

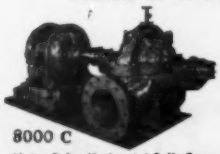
For further information write R-S Products Corporation, Wayne Junction, Philadelphia 44, referring by number to this PETROLEUM REFINER item 329.

Motor Protection (Item 330)

Featuring a cast iron frame which surrounds all working parts, a double insulated stator, a die-cast rotor, ventilation, drip-proof end brackets, prelubricated bearings, machined feet, and conduit box, Bulletin 51B6210B describes the design and construction of "Safety-Circle" motors of Allis-Chalmers Manufacturing Company. Drip-proof and splash-proof motors are available in sizes from one hp. at 1800 rpm. to 20 hp. at 3600 rpm., in frames 326 and smaller.

PUMPS

BUILDERS OF OUTSTANDING PUMPS SINCE 1869



8000 C

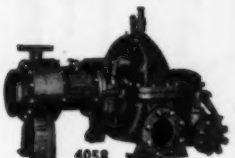
Motor Drive Horizontal Split Case Double Suction Centrifugal Pump

8001

Turbine Drive Horizontal Split Case Multi Stage Centrifugal Pump

4049 A

Two Stage Close Coupled Centrifugal Pump



4058

Turbine Drive Close Coupled Centrifugal Pump

942

Single Style, Packed Piston Pattern Steam Pump

2352 B

Durable Duplex, Outside End Packed, Plunger Pattern Steam Pump

3918

Durable Duplex, Packed Piston Patern Steam Pump

3833

Horizontal Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W. TENTH ST.

All dimensions are NEMA standards. The advantage of "Safety-Circle" design are pointed out as non-ventilated, fan-cooled, and explosion-proof.

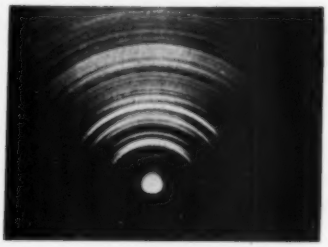
For a copy write Allis-Chalmers Manufacturing Co., 1062 South 70th Street, Milwaukee, Wisconsin, referring by number to this PETROLEUM REFINER item 330.

New Valve Body (Item 331)

A re-designed valve body by Edward Valves, Inc., "reduces pressure loss 40 percent thus enabling a size smaller check valve to do the work of a larger valve." The smaller body size achieved through the use of integral Stellite seat and Edward equalizer allows the disk piston to rise out of the path of flow, thus utilizing the flow passage. Bonnet bore is only slightly larger than the ASA standard for port openings. Equalization of pressure in all internal areas of the valve, reduction of weight in the floating disk piston, and stream lined internal contours, which eliminate wear producing turbulence, combine to decrease pressure loss in the new body design. Check valves with new body design are built in 900, 1500 and 2500-pound classes with both globe and angle patterns. They are available with pressure-seal or bolted bonnet and with flanged or welding ends.

For further information write Edward Valves, Inc., Rockwell Manufacturing Company, East Chicago, Ind., referring by number to this PETROLEUM REFINER item 331.

Electron Diffraction Instrument (Item 332)



Electron diffraction pattern of iron oxide as it occurs on steel surfaces subjected to high temperatures.

General Electric Company has developed the electron diffraction instrument to study a layer of metal less than a quarter-millionth of an inch thick. It can be used to determine the effects of lubricants and in friction studies of polished metal engine parts, especially the jet engine. Used to study parts which have been worn by tests, the device helps discover and minimize the causes of friction. The instrument can also detect natural films emanating from the steel and chemical changes produced on the surfaces by lubricants. A stream of electrons are "boiled off" a white-hot tungsten filament and focused into a beam by a magnetic lens. The beam then is either passed through a two-millionths-inch-thick section of metal and produces an image on a fluorescent screen or on a piece of ordinary photographic film, or the beam is directed to a metal surface at an angle. The image produced is different for each material and can determine both surface conditions and crystal arrangement of the molecules of metal. Projections on the surface diffract the electrons and form the image. The electrons travel in a chamber evacuated to a pressure of approximately one eight-millionth that of normal air pressure.

For further information write General Electric Company, 1 River Road, Schenectady 5, N. Y., referring by number to this PETROLEUM REFINER item 332.

Gear Type Winch (Item 333)

A separate unit planetary gear type winch is being manufactured by Lewis-Shepard Products Inc. Made of treated alloy steel, the winch "can be mounted

SCHOTCO Filter BLANKETS

USED BY THE OIL INDUSTRY FOR MANY YEARS

TIME TESTED—ENGINEERED TO MEET THE MOST RIGID TESTS

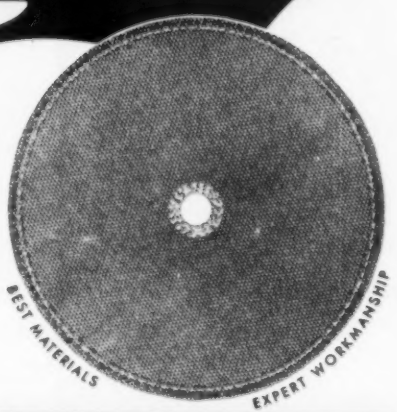
Schott Brothers have been manufacturing wax press Filter Blankets for a great number of the nation's refineries for many years.

Our particular blankets have been accepted and approved in the refining trade. They are constructed to meet the most grueling conditions and rigid tests.

We can also produce filter blankets per your particular specifications. Large capacity will assure you of prompt delivery.

Write us for further information. Prices and samples on request. We will be very glad to assist on any filter problem you may have.

SIDEVIEW



THE SCHOTT BROS. CO., INC.

WEST SALEM, OHIO, U. S. A.

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Good fuels and lubricants, for both pleasure and commercial planes, are made *better* with PARAMINS additives. Now used from coast-to-coast to stabilize high-octane aviation gasoline and improve light aircraft lubricants, PARAMINS show outstanding results in *extra* service with fewer overhauls. Continuing research...in America's largest, most-up-to-date petroleum laboratories...assures continuous high standards of quality in PARAMINS.

Proved PARAMINS for improved oils and fuels!

PARATONE, for improved viscosity index; **PARAFLOW,** for lower stable pour; **PARATAC,** for tacky oils and greases; **PARAPOID,** for E. P. gear oils; **PARANOX,** for oxidation inhibition and detergency; **PARASHEEN,** for better appearance; **PARADYNE,** for improved gasoline.

ENJAY COMPANY, INC.

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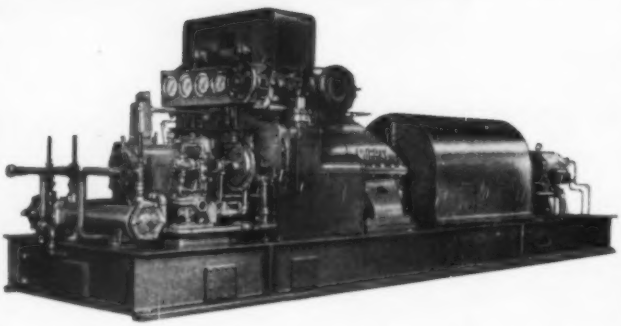
PIONEERS IN CHEMICALS FROM PETROLEUM

Additives, Alcohols, Esters, Ketones, Plastics and Oil-Resistant Rubbers

MURRAY

TYPE D TURBO-GENERATOR



Murray Type D turbo-generators are built in a capacity range from 500-3000 KW. Turbines are either direct-connected to 2-pole generators or operate through reduction gears connected to 6-pole generators at 1200 RPM. Direct current and 25 cycle machines are also available. This type machine is regularly furnished in the above capacity range either condensing or non-condensing and may be of the automatic extraction type or for high back pressure. Units may be mounted either on soleplates or on a fabricated steel base.

This type turbo-generator is designed to operate on steam conditions up to 600#, 750° F. TT. Auxiliary equipment normally includes combined trip throttle valve, complete pressure lubrication system including oil tank, oil filter, coolers, and automatic turbine-driven auxiliary oil pump. Gauge board with gauges, vibrating reed tachometer and necessary thermometers are also furnished.

The above photograph shows a machine of this type rated at 1000 KW. Two duplicate machines are installed in our Nation's Capitol.

Murray turbo-generators have long been noted for their rugged construction, operating economy and long life with a minimum of maintenance.

WRITE TODAY FOR FULL DETAILS

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA

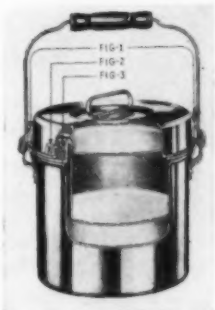
BUILDERS OF STEAM POWER EQUIPMENT
FOR THREE QUARTERS OF A CENTURY

New Equipment

in any position" on a 5 by 5¼-inch steel plate. All mechanisms are contained within the winch drum which is 4 inches in diameter and 6¼ inches long. Its flanges are 6 inches in diameter. A total of 25 feet can be wound in two layers on the drum. Other features are a 12 inch "crank up, crank down" handle, direct cable pull of 600 pounds, positive acting brake, and swaged type fitting.

For further information write Lewis-Shepard Products Inc., 268 Walnut Street, Watertown 72, Mass., referring by number to this PETROLEUM REFINER item 333.

Dinner Pail (Item 334)



Republic Stamping and Enameling Company has improved the old dinner bucket into a "heavy-gauge, all-aluminum, round, rust-proof dinner pail fitted with tight food and water compartments." Spring locks on each side hold all parts together. A bayonet lock on the cover makes it possible to lift out the food compartments as a unit. The large inset pan will accommodate two quarts of food and the overlapping collar protects food from water spilling in or dust seepage. Dessert and utensil tray

is on top. The outside pan will hold three quarts of liquid.

For further information write Republic Stamping and Enameling Company, Canton, Ohio, referring to PETROLEUM REFINER item 334.

Extinguisher (Item 335)

Approved by Underwriters' Laboratories, the new dry chemical extinguisher developed by The General Detroit Corporation and The General Pacific Corporation, its west coast affiliate, has a special conical bottom which funnels a fine white powder to the outlet. A small carbon dioxide cylinder "delivers the powder in a stream as long as 25 feet." The heat of the fire releases the carbon dioxide gas from the powder. Contained inside the shell, the cylinder is punctured by squeezing a valve on top of the extinguisher. A second valve directs and controls the flow.

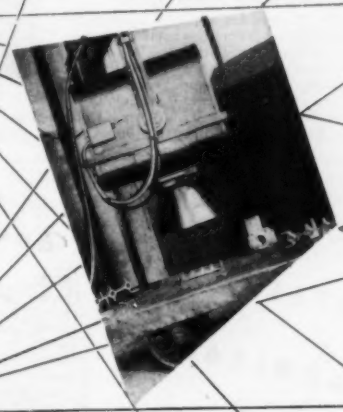
For further information write The General Pacific Corporation, Los Angeles and The General Detroit Corporation, Detroit, referring by number to this PETROLEUM REFINER item 335.

Centrifuge (Item 336)

Model L Spinco preparative centrifuge, manufactured by Specialized Instruments Corporation, is the vacuum-chamber type with a two-stage mechanical pump. Electronic control, speed control, braking and a shutdown device are all automatic. Rotors 6¾ inches in diameter hold 150 cc. of material and make 40,000 rpm. The 11-inch (diameter) rotor holds a liter and makes 20,000 rpm. The manufacturer claims the speed is limited to safe operation for each size. The unit will not operate unless the rotor chamber is properly evacuated, the vacuum chamber will not open during the operation and a warning light flashes when the oil supply is low. Refrigeration facilities are also available. All moving parts of the mechanism operate in an oil-mist

DURALOY

High Alloy CASTINGS



X-rayed by 250,000 Volts

...And we also have Gamma-ray inspection of castings!

Working on the theory that the production of sound high alloy castings calls for more than metallurgical and foundry skill, we have carried out a modernization program in our shop to make it "the last word" in chrome-iron and chrome-nickel production facilities.

Complementing the X-ray and Gamma-ray inspection facilities, we have seven of the latest type electric furnaces (5 arc-type and 2 high frequency type) with capacities ranging from 100 to 6500 pounds per furnace. We have sand-control and sand-treating apparatus. We have one of the best control and analytical laboratories in the industry.

Send for our General Catalog 4729-G

If you would like to have your chrome-iron or chrome-nickel castings made in our modern well-equipped foundry by experienced metallurgists and skilled foundrymen, we shall be glad to take care of your order.

THE DURALOY COMPANY

Offices: Plant: Scottdale, Pa. • Executive Offices: 17 East 42nd Street, New York 17, N. Y.

F. O. NELSON
1743 McCormick Building
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METAL GOODS CORP: St. Louis • Houston • Dallas • Tulsa • New Orleans • Kansas City

bath. The 1¼-hp. motor operates on 115/230-volt, 50 or 60 cycle power.

For further information write Specialized Instruments Corporation, 648 O'Neill Avenue, Belmont, Calif., referring by number to this PETROLEUM REFINER item 336.

Metal Jacketing (Item 337)

A new method for applying protective metal jacketing over insulated lines has been developed by Minnesota Mining & Manufacturing Company and Childers Manufacturing Company. The metal jacketing material is light weight aluminum, ribbed with 3/16-inch corrugation, and is flexible enough to put onto the

lines with bands of plastic film scotch tape. It is claimed the tape will not loosen or harden in the weather elements or dampness, is resistant to heat up to 170° F. and sub-zero temperature and is also resistant to acids, alkalis and hydrocarbon products found in most process plants.

For further information write Childers Manufacturing Company, 625 Yale Street, Houston, referring by number to this PETROLEUM REFINER item 337.

Control Valve (Item 338)

The valve body of the new Domotor control valve, manufactured by The Annin Company, consists of two castings bolted together with the seat ring serving as a bridge or separation unit. The body parts may be rotated about the seat ring in assembly to form a right hand angle, left hand angle or a straight through pattern. An adapter makes a conventional angle pattern valve body possible. Featuring longer strokes, an integral valve positioner unit is incorporated in the piston actuated assembly. Its only connection with the moving mechanism is a frictionless spring.

For further information write The Annin Company, Los Angeles, referring to PETROLEUM REFINER item 338.

Receding Die-Stock (Item 339)

The new pipe threading tool of The Oster Manufacturing Company is built "to withstand the strain when used with drive shaft for power operation with a portable pipe machine." For hand operation the tool is used with a ratchet handle. This geared receding die-stock has a drive gear with tensile strength of 40,000 to 60,000 psi. The complete tool is furnished with four individual sets of dies, each set threading one pipe size only. The four standard pipe sizes are 2½, 3, 3½ and 4 inches. Die holder is a separate unit and is adjustable to permit cutting oversize and undersize threads. Graduations on the pinion shaft housing indicate correct length of thread to be cut. Lifting handles are "carefully balanced at the center of gravity so the tools can be readily placed in position on the pipe." Design of the gear body hood permits "easy

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STEEL, ALLOY and COPPER
FABRICATION

FOR REFINERIES • CHEMICAL PLANTS
PIPE LINE PUMP STATIONS AND
GAS PROCESSING PLANTS

Levingston
SHIPBUILDING CO. · ORANGE, TEXAS

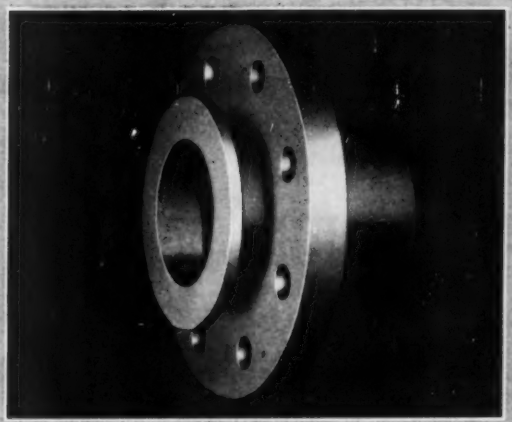
MIDWEST WELDING FITTINGS
Improve Piping Designs and Reduce Costs

IN WELDED · PIPING SYSTEMS

SAVE TIME and MONEY on EQUIPMENT CONNECTIONS

by using MIDWEST

LAP JOINT STUB ENDS



Substantial savings of time and money result if Midwest Lap Joint Stub Ends are used when making connections to valves, equipment or other flanged outlets in welded piping systems. They have important advantages over flanges welded to the pipe.

The swivel flange makes it unnecessary to line up the bolt holes before welding. Setting up is quick and simple because no special clamps or jigs are required to hold the face of the flange absolutely perpendicular to the axis of the pipe. Field crews report as high as 25% saving in erection time for making up a joint using Midwest Lap Joint Stub Ends in comparison with rigidly fixed flanges.

Midwest Welding Fittings improve piping—save money. Get in touch with the distributor near you.

3719

MIDWEST PIPING & SUPPLY COMPANY, Inc.

Main Offices: 1450 South Second Street, St. Louis (4), Mo.
Sales Offices: New York (7), 30 Church St.
Chicago (3), 79 West Monroe St. • Los Angeles (33), 520 Anderson St. • Houston (2), 229 Shell Bldg. • Tulsa (3), 533 Maye Bldg. • South Boston (27), 426 First St. • Distributors in Principal Cities.

backing off of the tool when the dies recede slightly from the cutting position."

For further information write The Oster Manufacturing Company, 2057 East 61st Street, Cleveland 3, Ohio, referring to PETROLEUM REFINER item 339.

Silicone Rubber Bond (Item 340)

For electrical applications, and for use in handling hot or cold fluids and gases, The Stalwart Rubber Company recommends silicone rubber bonded to fiberglas, asbestos, wool or cotton. It is claimed that bonding synthetic rubber

to these materials increases its strength and suitability for high pressure gasket and diaphragm applications.

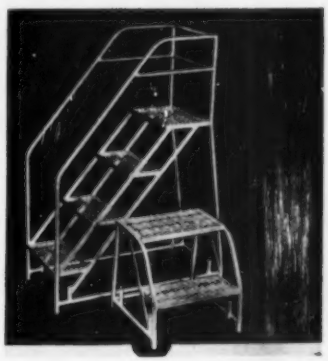
For further information write The Stalwart Rubber Company, 189 Northfield, Bedford, Ohio, referring by number to this PETROLEUM REFINER item.

Photoelectric Colorimeter (Item 341)

Matching of the photoelectric cell and the direct reading microammeter gives the new Rouy Photrometer, made by E. Leitz, Inc., a concentration reading claimed to be accurate to within 0.1 percent. The measured electrical energy is "linear to the transmitted light energy." All adjustments are made with a single control and the ten narrow band (40 millimicrons) glass filters are "matched to produce identical spectral transmission curves." A precision square absorption cell is also used for greater accuracy. The instrument takes a 115-volt ac. line, but it can be used with a 6-volt storage battery for dc.

For further information write E. Leitz, Inc., 304 Hudson Street, New York 13, referring by number to this PETROLEUM REFINER item.

Mobile Step Ladder (Item 342)



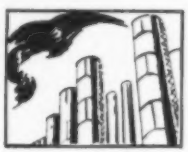
A mobile step ladder of The Ballymore Company of Philadelphia incorporates an automatic safety feature "which prevents rolling or slipping when in use." The ladder is mounted on ball bearing castors but when it is in use, the rubber-tipped legs automatically touch the floor giving a brake effect. It is designed for use in stock rooms, parts storage, filing departments and maintenance crews. The ladder is made in standard sizes from 1 to 6 steps out of aluminum finished steel with a frame of ¾-inch steel tubing and steel, non-slip step plates electrically welded. Handrails and a removable steel mesh basket are optional on the safety ladders having from 3 to 6 steps.

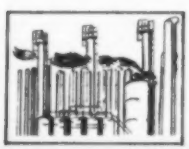
For further information write for the catalogue to The Ballymore Company, 3 S. Roberts Road, Bryn Mawr, Pa., referring by number to this PETROLEUM REFINER item.

Flame Spraying Method (Item 343)

A successful method for the flame spraying of polythene on metal surfaces has been developed by the engineering research laboratory of the Du Pont Company. Approximately 16 square feet per hour can be covered. Tests indicate that "adhesion is good and temperatures

Sheffield
ALUMINUM TANK PAINT
Laboratory Tested





Extensive weather-o-meter tests prove this NEW aluminum paint will resist more than one and one-half years exposure to weather extremes! Formulated to do TWO specific jobs—to protect surfaces against rust, wear and corrosion . . . and to add a long lasting attractive finish . . . Sheffield TANK PAINT has been made especially to overcome the expensive maintenance and finishing problem facing the oil industry.

- Made of only the finest, uniform aluminum linings — top quality!
- Formulated with a special long oil alkyd synthetic resin vehicle in conjunction with other synthetic resin. These give a high resistance to abrasion and chemical fumes.
- Covers all primed surfaces in ONE COAT, giving a tough, elastic durable finish . . . actually a coating of finest aluminum.

Write for descriptive folder . . prices and samples sent upon request.

THE SHEFFIELD BRONZE PAINT CORPORATION
17814 WATERLOO ROAD • CLEVELAND 19, OHIO
One of the World's Largest Manufacturers of Aluminum Paints and Paint Specialties

used do not degrade the polythene." Exposure tests of 300 days duration with sulfuric, hydrochloric, and other acids "have shown no deterioration in coating properties or base metal attack."

For further information write E. I. du Pont de Nemours & Company, Petroleum Chemical Division, Wilmington, Delaware, referring by number to this PETROLEUM REFINER item.

Twin Strainers (Item 344)

A new line of twin strainers, manufactured by Elliot Company, are illustrated and explained in Bulletin A-13. They are available in sizes up to 24 inches for use at pressures up to 125 and 250 psi. Constructed with two strainer chambers in one body, either chamber can be shut off for removing and cleaning the strainer basket. Since the strainers have no moving parts except valve mechanism, maintenance is held to a minimum.

For a copy write Elliott Company, Jeannette, Pa., referring by number to this PETROLEUM REFINER item.

Socket Wrenches (Item 345)

In order to increase the utility of socket sets, Plomb Tool Company has added 12 new Pronto socket wrenches, including a ¼-inch drive, 8-point socket with a ¾ inch opening; ⅜-inch drive, 8-point sockets with openings of ¼, 5/16, ⅜, 7/16 and ½ inches; ⅜-inch drive, 12-point sockets with 13/16 and ⅞-inch openings; a universal type ⅜-inch drive, 12-point socket with 13/16-inch opening; a ½-inch drive, 12-point socket with ⅜-inch opening and ⅜-inch drive screwdriver sockets.

For further information write Plomb Tool Company, Los Angeles 54, referring to PETROLEUM REFINER item 345.

Voltage Regulation (Item 346)

Sorensen and Company, Inc., are publishing a bi-monthly house organ, "Currently," devoted to developments in the voltage regulation field. New applications of electronic voltage control equipment and articles on the company's contribution to voltage control theory will be featured.

For a copy write Sorensen and Company, Inc., 375 Fairfield Avenue, Stamford, Conn., referring to PETROLEUM REFINER item 346.

Industrial Fire Hose (Item 347)

Brands of industrial fire hose are pictured with data on size in a catalog of The B. F. Goodrich Company. Couplings, test pressures, weight coupled and uncoupled for 50-foot lengths are explained along with descriptions of gaskets, fittings and couplings. Methods and materials of construction plus advantages of fire hose uses are also discussed.

For a copy write The B. F. Goodrich Company, Akron, Ohio, referring by number to this PETROLEUM REFINER item.

Precision Equipment (Item 348)

Laboratory Equipment Corporation has developed the following precision control equipment: LECO 2400° and 2800° F. furnace; LECO No. 4000 semi-automtaic carbon determinator; LECO No. 4500 precision carbon determinators; and LECO hf. series combustion boats.

For further information write Laboratory Equipment Corporation, St. Joseph, Mich., referring by number to this PETROLEUM REFINER item.

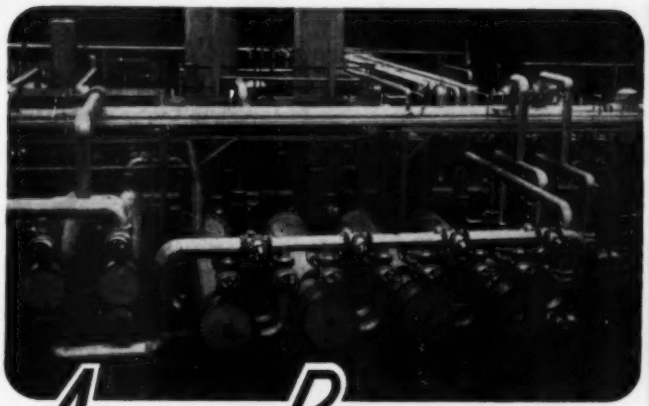
Cork Finish (Item 349)

Used as an adhesive or finish for corkboard or cork covering to help prevent damage to the insulation from solvent products, Solvopruf, developed by Armstrong Cork Company, sets to a rubber-like film at room temperature and may be exposed to temperatures

New Equipment

Western Engineered Products

for GASOLINE PLANT EFFICIENCY



AMERICAN REPUBLICS CORP.

At American Republics' gasoline plant at Silsbee, Texas—recently completed by Gasoline Plant Construction Corporation—Western heat transfer equipment plays an important part in the plant's manufacturing efficiency. Rigid adherence to engineering detail and specification assures dependability in Western equipment for gasoline plants, refineries, chemical processing plants and pipe lines throughout the world.

WESTERN
HEAT EXCHANGERS
Manufactured by
WESTERN SUPPLY COMPANY
P.O. BOX 1888 TULSA, OKLAHOMA
SALES OFFICES – DALLAS – HOUSTON

See Western's catalog pages in the current issues of Chemical Engineering Catalog, Refinery Catalog, and Thomas Register.

from minus 35° to plus 125° F. Applied by brush or trowel, the compound is claimed to be resistant to the action of toluol, methyl ethyl ketone, gasoline, kerosine and water when aged for several days. Benzol will make the product swell, according to the company, but it will remain in serviceable condition.

For further information write Armstrong Cork Company, Lancaster, Pa., referring by number to this PETROLEUM REFINER item.

Grid Trays (Item 350)

Applications of grid trays for handling filtering material are described in Catalog G-48, published by Kerlow Steel Flooring Company. Dimensions of eight different patterns of grid trays, a safe load table and other engineering data to help in the selection of trays are given.

For a copy of the catalog, write Kerlow Steel Flooring Company, 220 Culver Avenue, Jersey City 5, N. J., referring to PETROLEUM REFINER item 350.

Radioactive Tracers (Item 351)

Arthur D. Little, Inc. has prepared a bibliography on the industrial uses of radioactive tracers. General background references and survey articles of industrial applications are included. References for specific fields are also given.

For a copy of the bibliography write Arthur D. Little, Inc., Cambridge 48, Mass., referring to PETROLUEM REFINER item 351.

Extension Shoes (Item 352)

Straddle truck extension shoes, claimed to increase the possible length of palletized loads and eliminate the necessity of special large skids or platforms, are being manufactured by Hyster Company. The shoes bolt to the regular gripping shoes of the truck. It is claimed that 40 filled drums, weighing approximately 10 tons, can be picked up and transported in one trip. Extensions include one with fork-like fingers designed to fit into the sides of the pallets for lifting and one of plain angle iron type.

Fort further information write Hyster Company, Portland 8, Ore., referring by number to this PETROLEUM REFINER item.

Temperature Control (Item 353)

Wheelco Comments, house organ of Wheelco Instruments Company, contains four types of temperature control applications. Included are a description of a small continuous furnace at Ferro Enamel Corporation, an explanation of the new turbine blade fatigue tester built by Baldwin Locomotive Company, a new high capacity injection molding machine, manufactured by Watson-Stillman Company, and a listing of the instruments in operation at the Metlox Manufacturing Company's pottery plant.

For a copy of the publication write Wheelco Instruments Company, 847 W. Harrison Street, Chicago 7, referring by number to this PETROLEUM REFINER item.

Control Valve (Item 354)

Specifications and applications of the liquid level control valve of The Parker Appliance Company are presented in Bulletin 530. Diagrams illustrate single-point servicing and underwing fueling of aircraft. The valves are designed "for control of liquid levels independent of flow rates or pressures, with a minimum pressure drop."

For a copy write The Parker Appliance Company, 17325 Euclid Avenue, Cleveland 12, Ohio, referring by number to this PETROLEUM REFINER item.

Structural Welding (Item 355)

Air Reduction Sales Company has increased the price of its structural welding text book, "Manual of Design for Arc Welded Steel Structures," from $2. to $3. Fundamentals of design, materials, inspection, estimating and engineering control of welding and related operations are presented. Electrode requirements, specifications for welded connections for all sizes of rolled beams and a series of diagrams for the rapid design of welded connections are also included. The

Specializing In
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Unloading and Hauling, Preparing to Erect 65 Ton "Bubble Tower"

A Complete Organization Serving the Major Industries
Throughout the Southwest for 66 Years.
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RIGGING & HEAVY HAULING CO., INC.
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Pump Packing Troubles

may mean costly shutdowns. Packing troubles ALWAYS mean higher operating costs. Have you tried Centrifugal Pumps which require NO packing? Most satisfactory for pumping acid and other corrosive liquids.

Descriptive Bulletin on Request

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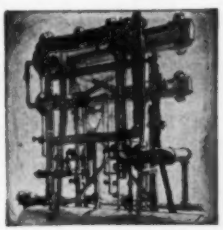
VACUUM

99.99% PERFECT

This degree of vacuum referred to the average sea level barometer is maintained by the Croll-Reynolds five stage steam jet EVACTOR. If five stages sound complicated consider the fact that there are absolutely no moving parts. Each stage from a mechanical standpoint is as simple as the valve that turns it on. Numerous four stage units for maintaining industrial vacuum down to 0.2 mm. and less, and many thousands of one, two and three stage units are maintaining vacuum for intermediate industrial requirements on practically all types of processing equipment.

An engineering staff of many years experience has specialized on this type of equipment and has contributed toward the development of several vacuum processes which have revolutionized certain manufacturing operations, improved certain commercial products, and assisted in the development of new products.



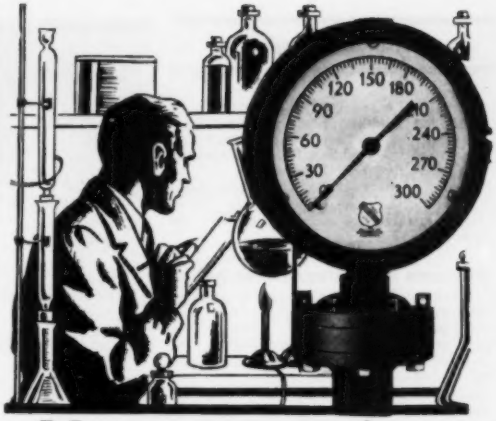
Vacuum cooling units well known to industry as Croll-Reynolds CHILL-VACTORS and water jet ejectors round out this line of specialized equipment.

CROLL-REYNOLDS

CROLL-REYNOLDS CO.

17 JOHN STREET, NEW YORK 7, N. Y.

CHILL VACTORS STEAM JET EVACTORS CONDENSING EQUIPMENT



Name your poison

CHEMICALS, Corrosives, Catalysts, Acids, and Viscous materials used in modern refining and industrial processes, are all safely and easily handled by the ASHCROFT CHEMICAL GAUGE.

With diaphragms and diaphragm chambers protected by stainless steels, lead, tin, silver, platinum, tantalum, rubber, nickel, Hastelloy, Beryllium Bronze and other special materials, this gauge is the answer to the many pressure indicating problems constantly confronting the Chemical, Petroleum, or Metallurgical Engineer.

Viscous substances cannot clog the gauge mechanism. A removable diaphragm housing and oversize pipe connection provides easy accessibility for cleaning. Special flange mounting construction permits direct attachment to apparatus when desirable for fluids which harden at atmospheric temperatures.

Furnished for all pressures up to 1000 p.s.i., the ASHCROFT CHEMICAL GAUGE incorporates the famous Rotary Geared Movement, the corrosion-resistant laminated plastic dial, and other outstanding features which have contributed to ASHCROFT leadership for nearly 100 years.

Stocked and sold by leading Distributors everywhere...When you order gauges, insist on ASHCROFT...Write for booklet.

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ASHCROFT *Gauges*

A Product of

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Makers of Ashcroft Gauges, Hancock Valves, Consolidated Safety and Relief Valves and 'American' Indust ial Instruments. Builders of 'Shaw-Box' Cranes 'Budgit' and 'Load Lifter' Hoists and other lifting specialties.

manual is based on standards of the American Welding Society, The American Institute of Steel Construction and reports of the Welding Research Council of the Engineering Foundation.

For a copy write Air Reduction Sales Company, 60 East 42nd Street, New York 17, referring to PETROLUEM REFINER item 355.

Pressure Regulators (Item 356)

O. C. Keckley Company's catalog features precision regulators, temperature regulators, combination pressure and temperature regulators, float valves, self-cleaning strainers and steam traps. It includes dimensions, application, capacity, engineering tables and specifications.

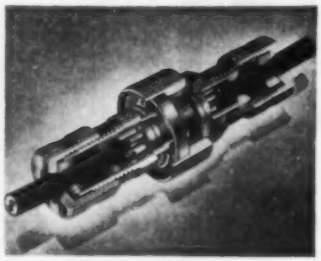
For a copy write O. C. Keckley Company, 400 West Madison Street, Chicago 6, referring by number to this PETROLEUM REFINER item.

Heat Treating (Item 357)

"Shop Notes on Heat Treating of Steels," a booklet of Cooley Electric Manufacturing Corporation, Indiana, discusses typical heat treating procedures (including heating, quenching, tempering, and atmosphere control) and tips for better heat treating. Definitions of heat treating terms are also given.

For a copy write Cooley Electric Manufacturing Corporation, 38 South Shelby Street, Indianapolis 7, Ind., referring by number to this PETROLEUM REFINER item.

Electrical Coupling (Item 358)



A quick disconnect electrical coupling for all-weather and submarine applications is a new development of Roylyn Inc. Known as the 1600 Series, the connector is "impervious to moisture and capable of withstanding long periods of complete immersion under high external pressure without leakage." The couplings are provided with pressure tight cable seals or are threaded for attachment to conduit, bulkheads or panels. Electrical inserts are manufactured to Army-Navy specifications and employ phenolic material of high dialectric qualities.

For further information write Roylyn Inc., 718 West Wilson Avenue, Glendale 3, Calif., referring by number to this PETROLEUM REFINER item.

Gas Detector (Item 359)

Approved by the Underwriters' Laboratories and the Associated Factory Mutual Fire Insurance Company, the combustible gas detector and safety controller offered by Lor-Ann Instrument Company, Inc., continually samples and analyzes plant atmosphere. When gas accumulation becomes dangerous, an automatic alarm is given and the instrument "automatically takes over control of the plant's operating machinery, fire-fighting system or ventilation system." From the control cabinet, tubing leads to the gas analysis cells placed at danger points. The analysis takes place in the gaseous area and is "telegraphed" to the control panel. The alarm point can be set "from 20-100 percent of the lower explosive limit for any given gas." Provided with a 3-wire grounded neutral protective system, the instrument operates on 110 volts 60 cycles. It also has a separate signaling system to indicate any failure of the actual instrument to operate.

For further information write Lor-Ann Instrument Company, Inc., 58 Montgomery Street, Jersey City, N. J., referring by number to this PETROLEUM REFINER item.

Fuller's Earth (Item 360)

Western Clay & Metals Company, in a new bulletin, describes its Utah Standard fuller's earth.

For a copy write Western Clay & Metals Company, 1 South Second Street, Alhambra, Calif., referring by number to this PETROLEUM REFINER item.

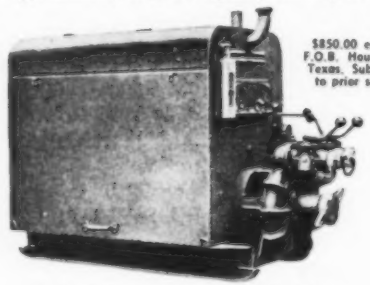
Pyrometers (Item 361)

Alnor 1160 pyrometer of Illinois Testing Laboratories, Inc. automatically measures cylinder exhaust temperatures of diesel engines. A clock-like dial indicates switch positions. The switch has a motor-driven, rotary-type arm, actuat-

FIRE PROTECTION!

Jetting—Transfer Work—Irrigation

We offer NEW surplus CHRYSLER-HALE Centrifugal Pumpers at approximately 50% of original purchase price.



$850.00 each F.O.B. Houston, Texas. Subject to prior sale

PUMP DATA

Hale Model OCD 1001
500 GPM—150 PSI—346 Ft. Hd.
HALE Ejector Priming
4" Suction — 2½" Discharges
N.S. Threads
Compact — Efficient
Quick opening valve on each discharge

ENGINE DATA

Chrysler T-118 (Ind. 7)
6 Cylinder
3-7/16" x 4¼" B & S
236 Cu. Inches Displ.
Radiator
Starting Equipment
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Write for catalog describing designs, advantages, installations, and with selection data.

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K E R L O W
OPEN STEEL FLOORING

ing leaf type contact assemblies. Overlaps in the switch "keep the pointer from returning to zero between positions." Any deviation from a general average is shown on the pyrometer scale. A push button stops the switch on any selected position for longer readings. Rotation speed is one rpm. The pyrometer can be equipped with an excess temperature cut-out.

For a copy of Bulletin 164 write Illinois Testing Laboratories, Inc., 420 North LaSalle Street, Chicago, referring to PETROLEUM REFINER item 361.

Dehumidification (Item 362)

Drying of air, gases and organic liquids in storage areas, handling materials, chemical processes, "spot" drying metallurgical work, air lines, as a production tool and for better finishes are discussed by Pittsburgh Lectrodryer Corporation in Bulletin 216. Illustrations of different applications are presented and the principle of drying by absorption is explained.

For a copy write Pittsburgh Lectrodryer Corporation, P. O. Box 1766, Pittsburgh 30, referring to PETROLEUM REFINER item 362.

Petroleum Sulphonates (Item 363)

Development of Petrosuls, petroleum sulphonates produced by Pennsylvania Refining Company, and its specifications are traced in a pamphlet. Surface active agents, Petrosuls are sodium salts of the sulfonic acids formed during the treatment of selected, high-quality petroleum distillates with oleum. They are available "in high or low molecular weights, possess high oil-solubility, surface active properties and stability characteristics."

For a copy of the pamphlet write Pennsylvania Refining Company, 2686 Lisbon Road, Cleveland 4, Ohio, referring to PETROLEUM REFINER item 363.

Magnesia Insulation (Item 364)

A manual on 85 percent magnesia insulation, published by the Magnesia Insulation Manufacturers Association, discusses properties, determination of correct thickness, application and finishing procedures and insulation maintenance. Practical applications of heat transmission theory, technical terms, data tables, glossary of trade terms and a list of trade names of the insulating material and accessory products appear in the appendix.

For a copy of the bulletin, to be published in July, write Magnesia Insulation Manufacturers Association, 1317 F Street, N. W., Washington 4, D. C. on company letter, referring to PETROLUEM REFINER item 364.

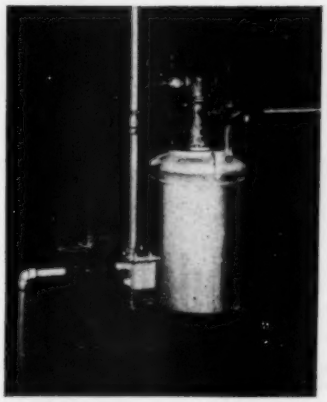
Nickel Alloys (Item 365)

Resistance of high nickel alloys to corrosion by sulfuric acid is discussed in Technical Bulletin T-3 issued by The International Nickel Company, Inc. Performance of 30 nickel-bearing materials is presented together with tables, graphs, and etc.

For a copy write The International Nickel Company, Inc., 67 Wall Street, New York 5, referring to PETROLUEM REFINER item 365.

Ejectopumps (Item 366)

The new ejectopump of Schutte and Koerting Company operates with compressed air from 30 to 50 psi. and handles "without aeration many liquids



of varying character and viscosity at temperatures up to 120° F. and higher depending on lift." Pumps have a maximum suction lift of 25 feet and the discharge heads up to 55 feet. It is claimed that the "ejectopump uses no impellers or rams, has no glands or bearings and no lubrication is required." Liquid handled "is not violently agitated or stirred and even suspended or included solids can be pumped." Entirely pneumatic, an air operated ejector in the pump head creates a vacuum throughout the pump and draws the liquid into the case. The liquid is discharged by displacment through the delivery pipe non-return valve.

For further information write Schutte and Koerting Company, 12 and Thompson Street, Philadelphia 22, referring by number to this PETROLEUM REFINER item 366.

Chromium-Iron (Item 367)

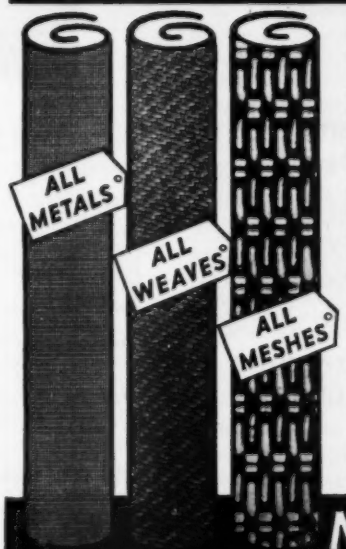
The properties and characteristics of 27 percent chromium-iron are presented in Bulletin TR-506, published by The Babcock & Wilcox Company. Illustrated with photographs, tables and graphs, the bulletin covers properties at elevated tempreatures, impact properties and notch sensitivity, structural characteristics, embrittlement phenomena, working and fabricating and heat treating.

For a copy of the bulletin write The Babcock & Wilcox Company, Beaver Falls, Pa., referring to PETROLEUM REFINER item 367.

Recording Viscometers (Item 368)

Design and operation of the new recording viscometer of Norcross Corporation is explained in bulletin V-1000A. It has both manual and automatic 24-hour control and can be operated on 110 volts 60 cycle supply capable of providing 2 amperes current. The cast aluminum recorder contains fractional horsepower motors, relays, switches, an alarm and various mechanical linkages. The recording chart "can be calibrated into any units desired." It operates on a plunger principle and the lift motor is a variable speed, completely enclosed motor. The mainte-

MULTI-METAL WIRE CLOTH



BY THE PIECE, YARD AND ROLL

There is a very definite reason why Multi-Metal wire and filter cloths have served so well in the process industries. It is the fact that Multi-Metal products are made to rigid standards of quality, both as to accuracy of design and metallurgical properties. As a result, Multi-Metal wire and filter cloth step up processing operations — reduce cleaning and repairing shutdowns — increase production capacity.

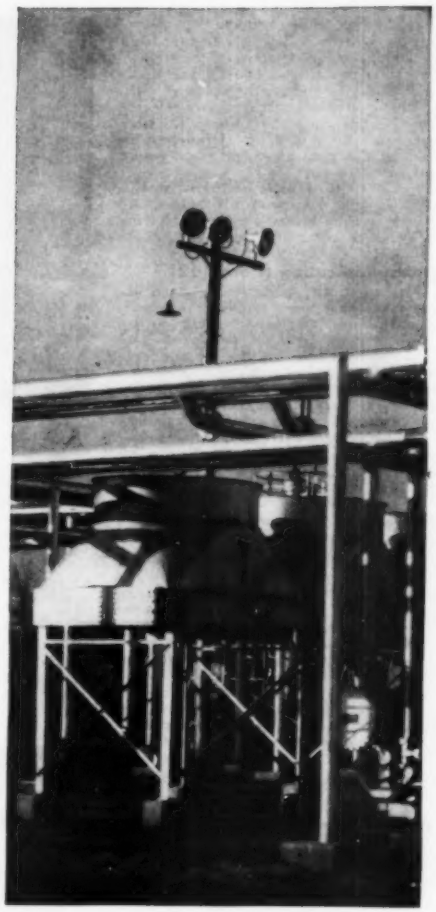
Wire cloth is supplied by the piece, yard, or roll. Standard meshes in stock are available for immediate shipment. Special types can be made for individual requirements.

Write today for our free catalog or mail a sample of the cloth you now use for recommendations.

More than 35 years of service to process industries

Multi-Metal
WIRE CLOTH COMPANY, INC.
1350 Garrison Ave., New York 59, N. Y.

6 Tough Cooling Duties in 1 Plant Handled by 1 Model ALCO Exchanger



The Skelly Oil Company gas plant at Velma, Oklahoma, built by the Born Engineering Company of Tulsa, presented a unique problem in certain process cooling requirements. Six different cooling jobs had to be handled in one battery, calling for different heat loads, temperature ranges and operating pressures.

One Alco air-cooled heat exchanger model (the uni-bundle*) was selected to handle all these cooling duties. The customer advises, "Units are operating successfully at over-design capacity." A fine example of how Alco *standardized* air-cooled exchangers can be tailored to suit customer needs—simplifying operation, maintenance, replacement of parts. Alco's *standardized* models bring low cost per year of operation and multiple savings in upkeep costs.

*Trademark patented

ARE YOU FACED WITH ANY OF THESE COOLING PROBLEMS?

- Insufficient water supply
- Scale from bad or brackish water
- Expensive water treatment
- Difficult waste water disposal
- High pumping costs
- High relative humidity
- Excessive space requirements for cooling basins

THEY CAN BE SOLVED INEXPENSIVELY BY ALCO AIR-COOLED EXCHANGERS

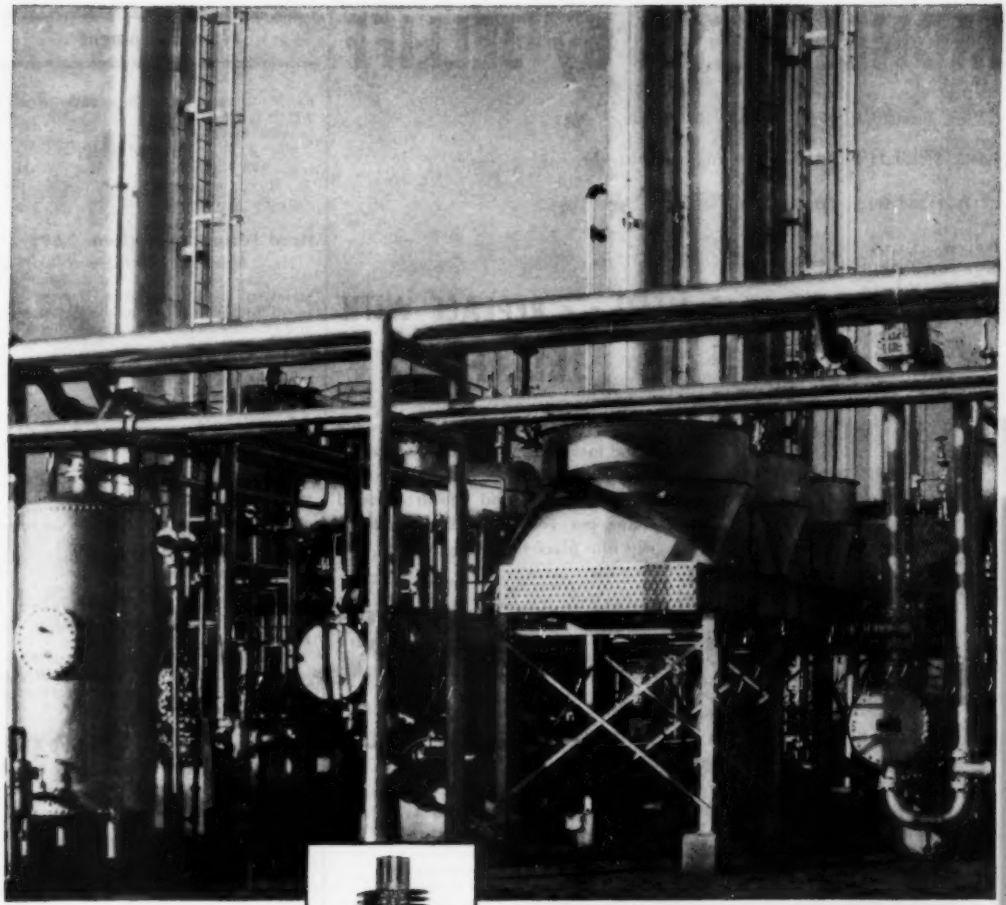
Proved in use in many of the nation's largest gas plants, in pump line stations, in power stations, in diesel locomotives—in many varied applications—Alco exchangers may be the answer to your specific problem.

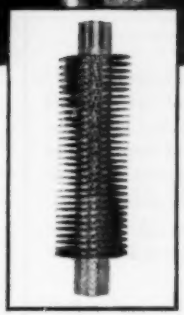
ADVANTAGES OF ALCO DESIGN

1. Volume production means standardized parts, easy maintenance, low cost per year of operation.
2. Simple field installation of standardized components.
3. Fans may be driven by any form of power.
4. Natural draft construction increases efficiency, reduces power requirements. Sometimes this natural draft is sufficient to produce adequate cooling without use of fans.
5. Wind direction and velocity do not affect efficiency.
6. Cooling surfaces positioned to minimize damage from wind-driven sand, rain, hail.
7. Induced draft insures uniform distribution of air across cooling surfaces.

FIN-TUBE MODELS CAN PERFORM MULTIPLE DUTIES

Selection of type of cooling surface to be used should be determined by economics and process requirements. As manufacturers of both radiator core and fin-tube types, and also as one of the world's largest makers of heat exchangers, Alco is in a position to give impartial advice.





Quality controls of Alco fin-tube manufacture assure highest heat dissipation rate. Fins wound on under pressure and permanently bonded on tube by means of solder bath completely covering fin and tube. Easy to handle, easy to clean with compressed air.

ADDITIONAL ADVANTAGES OF FIN-TUBE MODEL

1. Separate surfaces for separate cooling duties can be mounted in the same unit.
2. Header design permits variation of passes to suit process requirements of a given job, thus allowing selection of minimum surface within pressure drop limitation of the process while maintaining maximum velocity required for highest rate of heat transfer.
3. Orifices built into manifold-header design assure uniform distribution to entire cooling surface.
4. Bundle design of Alco fin-tube construction eliminates air leaks.

WRITE FOR FREE BOOKLET, just off the press, containing engineering, design, and selection data on Alco air-cooled heat exchangers. Learn how Alco can help you.

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HEAT EXCHANGER HEADQUARTERS

Dunkirk, N. Y. Beaumont, Texas

AMERICAN LOCOMOTIVE CO., Dept. H, Dunkirk, N. Y.

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☐ Please send me your Free new booklet on air-cooled heat exchangers.

☐ Have an Alco representative call, at no obligation to me.

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Company .....

Title .....

Address .....

MONEL MESH by JELLIFF

Even though your filters did not ★
have JELLIFF MESH as original ★
equipment, you can still ★
bring them "up to snuff." ★

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Not only Monel, either. Any ductile metal inert to your process—any mesh up to 200 x 200 or 50 x 750—in any suitable weave—and cut to size and shape per your blueprints, ready to slip into place for a long, useful, low-cost life.

WHEN YOU SPECIFY MESH . . . SPECIFY *JELLIFF'S*

Write Department 16

ACID GOT THE BITE ON YOU?

-pack it away with
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Built to take the punishment of sulphuric, nitric, mixed, heavy and other acids -- and service on all acid-handling pumps and valves. Select long fibre pure blue asbestos . . . each strand impregnated with special acid-resisting self lubricant. Will not score, overheat, or nitrate. Plaited, twisted, ring.

Let Palmetto Blue Asbestos also take the bite out of acid problems as pressure-bonded Sheet, as Dry Blue Rope.

• **Write for full particulars on the *entire* Palmetto line of packings for all industry.**

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NORTH WALES, PENNSYLVANIA

Contact your fully-stocked Palmetto distributor on all packing problems . . . ask him about our special tools.

New Equipment

nance of uniform warp and single end sizing is described in charts and specification diagrams.

For a copy write Norcross Corporation, 247 Newtonville Avenue, Newton 58, Mass., referring by number to this PETROLEUM REFINER item 368.

Hard Facing Wire (Item 369)

Hard facing Sprayweld wire used in the Sprayweld process and designed for standard metallizing guns is manufactured by Wall Colmonoy Corporation, and is described in a booklet containing application instructions, surface preparation, spraying and fusing, cooling and finishing, and settings on standard wire metallizing guns.

For a copy write Wall Colmonoy Corporation, 19345 John R Street, Detroit 3, referring by number to this PETROLEUM REFINER item 369.

Rotameters (Item 370)

Bulletin 18-RC explains the construction, operation and application of the electronic, electric and pneumatic recording and controlling rotameters, manufactured by Schutte and Koerting Company. Photographs, cut-away views, sectional drawings and functional diagrams accompany the text.

For a copy write Schutte and Koerting Company, 12 and Thompson Streets, Philadelphia 22, referring to PETROLUEM REFINER item 370.

Corrosion Protection (Item 371)

The Bird-Archer Company in a new folder describes the recently developed amine treatment which "tends to inhibit corrosion of boiler and condensate systems by surface protection of the metal itself as well as by raising the pH value of the condensate." Case histories and typical economics obtained by several power plants are given.

For a copy write The Bird-Archer Company, 400 Madison Avenue, New York, referring to PETROLUEM REFINER item 371.

Surface Active Agents (Item 372)

Seven grades of compositions, properties and surface tensions of Penn Drake Petrosuls or "mahogany soaps" are described in a Pennsylvania Refining Company pamphlet. Uses of Petrosuls as rust preventive compounds and soluble oils are also explained, as well as applications for emulsification, dispersion, mutual solvent and detergency.

For a copy write Pennsylvania Refining Company, 2686 Lisbon Road, Cleveland, Ohio, referring by number to this PETROLEUM REFINER item 372.

Water Hose (Item 373)

Illustrations and descriptions of each type water hose The B. F. Goodrich Company manufactures is described in Catalog 4800. Recommended uses, specifications and coupling information are included.

For a copy of the catalog write The B. F. Goodrich Company, Akron, Ohio, referring to PETROLEUM REFINER item 373.

New Equipment

Side-Entering Agitators (Item 374)

Design, construction features and application of the side-entering agitators of Industrial Process Engineers are described in Bulletin 482. Packed under pressure and with anti-friction bearings, the agitators "have deep stuffing boxes with lantern rings, generous shaft diameter and line-bored, all welded steel housing."

For a copy write Industrial Process Engineers, 8 Lister Avenue, Newark 5, N. J., referring by number to this PETROLEUM REFINER item 374.

Water Conditioning (Item 375)

Wright Chemical Corporation's new bulletin on water conditioning, scale control, and corrosion inhibition, lists recommendations of chemicals for these applications along with their properties and a general description of the product.

For a copy of the bulletin write Wright Chemical Corporation, 627 West Lake Street, Chicago 6, referring to PETROLEUM REFINER item 375.

Protective Coatings (Item 376)

Use and specification of Prufcoat protective coatings is given in a new folder issued by Prufcoat Laboratories, Inc. The packet contains reports from outside testing laboratories, actual case histories, the Prufcoat protectograph plan for analysing painting maintenance costs, price list and catalog information.

For a copy of the packet write Prufcoat Laboratories, Inc., 63 Main Street, Cambridge 42, Mass., referring to PETROLEUM REFINER item 376.

Control of pH (Item 377)

Equipment for the measurement and control of pH in industrial processing operations is described and illustrated in The Foxboro Company's bulletin 430. Explanation of pH value, effects, product quality, plant efficiency and operating profits is also given. Text and diagrams explain the theory of pH control instrumentation.

For a copy write The Foxboro Company, Foxboro, Mass., referring by number to this PETROLEUM REFINER item 377.

Bouncing Pipes (Item 378)

The story of oscillating molecules that impede the flow of gas and air through pipe lines is told in a new booklet, "Bouncing Pipes," published by The Burgess-Manning Company. Solutions for this problem through snubbers are offered. Bulletin 484 discusses the use of snubbers also.

For a copy of these publications write Burgess-Manning Company, Libertyville, Ill., referring to PETROLEUM REFINER item 378.

Wire Cloth (Item 379)

Specifications, descriptions and illustrations of meshes, weaves, metals and alloys included in the line of industrial wire cloths and screens is presented in the new catalog of Cambridge Wire Cloth Company. Typical examples and

"The lowest-cost gate valve we have ever used!"

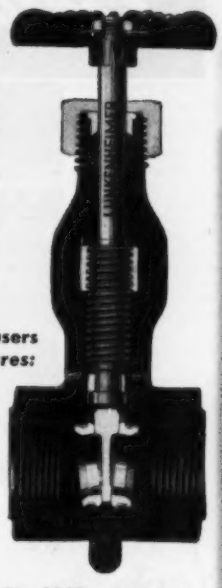
. . . that's what they say about the

LUNKENHEIMER

"King Clip" Gate Valve

THE first clip type valve was originally developed many years ago by Lunkenheimer and was one of the most popular gate valves ever designed. As service demands became more severe, the basic design was improved into the present "King-Clip". Twenty-one different patterns are now available for a wide range of service conditions in virtually all industries.

The "King-Clip" is truly the leader of all clip type valves . . . it offers you a money saving solution to many valve problems. See your Lunkenheimer Distributor. He has a stock available to serve you promptly. Write for Circular No. 561.



There are good reasons why so many valve users prefer "King-Clip" Valves. *Note these features:*

- Exceptionally strong body and bonnet construction.
- Extra length pipe threads for a strong, safe joint.
- Sharply tapered disc seats tightly.
- Large, unobstructed channels really drain the bonnet.
- Coarse stuffing box threads provide greater resistance to corrosion and stripping . . . reduce annoyance of leaky stuffing boxes.
- Easy to disassemble and reassemble.
- Exceptionally low maintenance cost.
- In bronze mounted patterns, rolled-in seat rings, integral non-corrodible stem thread bearing and special alloy stem assure longer life.

Fig. 1640 Iron Body Bronze Mounted . . . for steam, oil, gas, air, water and gasoline service.

Fig. 1644 All Iron . . . for handling solutions which attack bronze.

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THE LUNKENHEIMER CO.

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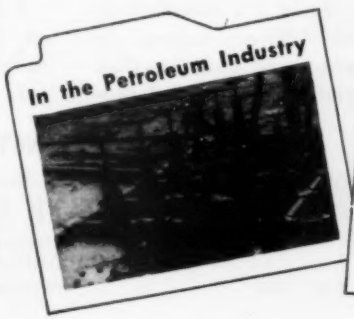

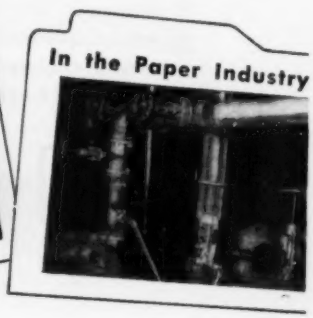

KEY TO EFFICIENCY IN A PIPE LINE TERMINAL

A complex piping set-up . . . pump house, valves, controls, pumps . . . is the key to efficient operation of this pipe line terminal.

Petroleum marketers, like refiners and chemical processors, have found the Graver Construction Co. a valuable help where operating efficiency depends on sound engineering and construction practices. Engineering, material procurement and on-the-site erection . . . all these are included in Graver's complete construction service. Organized to work with the petroleum and process industries, it is your assurance of a job well done.

For details on Graver's handling of any job . . . from equipment setting to complete plant construction . . . write today.

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NEW YORK PHILADELPHIA CHICAGO

applications of the company's wire filter cloths, screens and special fabrications as well as its facilities are shown. Metallurgical data also are presented.

For a copy write Cambridge Wire Cloth Company, Cambridge, Md., referring to PETROLEUM REFINER item 379.

Chippers' Goggle (Item 380)

A chippers' goggle, molded of phenolic compound and featuring dome metal side screens is presented by American Optical Company. The phenolic frame is non-flammable, moisture and heat resistant. Other features include a chain bridge enclosed in a plastic covered tube, large lens rings, and one-piece rubber headband. The goggle is fitted with regular plano lenses and can be had with 6-curve clear or Calobar types if desired.

For further information write American Optical Company, Southbridge, Mass., referring by number to this PETROLEUM REFINER item 380.

Metal Filter Cloth (Item 381)

Claimed to combine the advantages of very fine particle retention and favorable flow capacity with strength and corrosion resistant qualities, Michigan Specification 8700, a new metal filter cloth by Michigan Wire Cloth Company, is available in monel metal and Chromel C and is woven to special order in various alloys. It is recommended where fine straining action combined with free flowing qualities are essential. Specifications sheets list the cloth's physical characteristics.

For a sample of the cloth and a specification sheet write Michigan Wire Cloth Company, 2100 Howard Street, Detroit 16, referring to PETROLEUM REFINER item 381.

Full-View Rotameters (Item 382)

Brooks Rotameter Company bulletin 6 features full-view rotameters with safety shielding. It is manufactured in sizes from ¼ to 2-inch with screwed connections, and in sizes from 1 to 3-inch with flanged connections. Fully enclosed, the meter has all joints gasketed. Safety glass windows, ¼-inch thick, are in front and back. The long-scale hi-accuracy rotameter, stainless rotameter, multi-flow rotameter, dashpot meter for pulsation and the triple meter research kit are explained also.

For a copy write Brooks Rotameter Company, P. O. Box B-6549, Lansdale, Pa., referring by number to this PETROLEUM REFINER item 382.

Super Alloys (Item 383)

Tempil® Corporation's bulletin on super alloys lists elements contained in the 50 super alloy compositions available. Effects of different properties on the finished products are also discussed.

For a copy write Tempil® Corporation, 132 West 22nd Street, New York 11, referring to PETROLEUM REFINER item 383.

Unit Fabrication (Item 384)

Advantages and economies of factory unit-fabrication of welded piping headers, assemblies and valve groupings into one-piece pre-tested units are discussed in a Crane Company folder. Plant facilities are also explained. Photographs of sample unit-fabrications are shown and analyzed.

For a copy write Crane Company, 836 South Michigan Avenue, Chicago, referring by number to this PETROLEUM REFINER item 384.

Pressure Transmitter (Item 385)

Bulletin 102 of Moore Products Company presents a schematic diagram of the operation of the Nullmatic differential-pressure transmitter which offers "high accuracy, linearity, fast response, high overrange protection, no hysteresis, ease of installation, speed of transmission, safety, and dependable operation. A table of approximate transmitted pressure ranges is included.

For a copy write Moore Products Company, H and Lycoming Streets, Philadelphia 24, referring to PETROLEUM REFINER item 385.

Cast Iron Welding (Item 386)

The Linclon Electric Company's Bulletin 465 on cast iron welding presents applications, properties, procedure and current ranges for Ferroweld and Soft-weld an dprocedure for arc welding cast iron is given in detail.

For a copy write The Linclon Electric Company, Cleveland 1, Ohio, referring to PETROLEUM REFINER item 386.

New Equipment

Meters (Item 387)

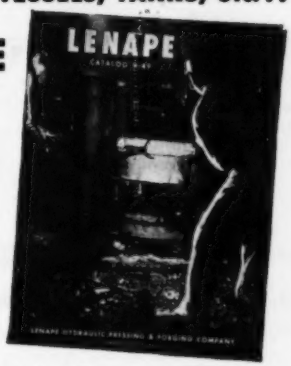
Ralph N. Brodie Company, Inc.'s bulletin describes its re-designed line of BiRotor petroleum meters which have interchangeable measuring unit assemblies. Two synchronized helical rotors rotate "in complete static and dynamic balance under all operating conditions."

For a copy of the bulletin write Ralph N. Brodie Company, Inc., Oakland, Calif., referring by number to this PETROLEUM REFINER item 387.

Dynalog Instruments (Item 388)

The Foxboro Company's Bulletin 427 explains the all-electronic Dynalog principle of operation, gives details of the construction of measurement and control instruments and advises as to the choice of resistance-type or e.m.f.-type instruments. Instruments shown with typical chart records include the multi-record dynalog, the segmental chart recorder, the scanning recorder, the dynalog controller and the dynalog indicator. Dimensional drawings and photographs of instrument panels give information on installation. A section of standard ranges

REFERENCE DATA
for Designers and Fabricators
of PRESSURE VESSELS, TANKS, etc...
ON
LENAPE
WELDING NECKS
MANWAY NECKS
NOZZLES
STUDDING OUTLETS
MANHOLE FITTINGS
COVERS
RINGS
SADDLES
PRESS FORMED PARTS AND PRESSURE VESSEL SPECIALTIES



60 pages of complete basic data, dimensions, pressure ranges, styles and types, code requirements, applications, and valuable handbook reference material. A copy of Lenape Catalog 949 will be sent upon request on company letterhead.

LENAPE HYDRAULIC PRESSING AND FORGING CO.
LENAPE HYDRAULIC PRESSING & FORGING CO.
DEPT. 706 WEST CHESTER, PA.
RED MAN PRODUCTS

available and directions to help in the selection of an instrument are also included.

For a copy write The Foxboro Company, Foxboro, Mass., referring by number to this PETROLEUM REFINER item 388.

Hour Recorder (Item 389)

Hourmaster, the new mechanical hour recorder of Barbour Stockwell Company, records the number of hours any piece of machinery or equipment with moving parts, has operated. It converts revolutions per minute, from 1 to 4000, into hours of operation. Space is provided for record cards which can be used to accumulate service, production or maintenance records. The manufacturer also claims that it assists in determining how often repairs and replacements are needed and necessary.

For further information write Barbour Stockwell Company, Cambridge 39, Mass., referring to PETROLEUM REFINER item 389.

Chemical Service (Item 390)

R. S. Aries & Associates have prepared a booklet on commercial chemical development services in which answers are given for these questions: What shall we produce, how much can we sell, in what form can our chemical products best be sold, at what price can we sell for maximum profit, and what qualities are required to assure maximum sales? The company's commercial chemical development plan is also discussed.

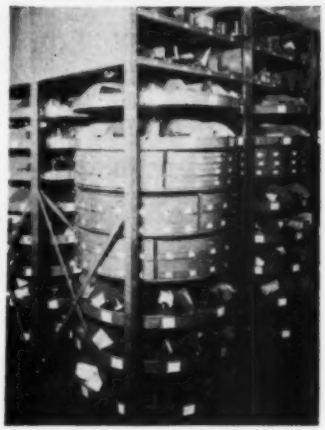
For a copy of the booklet write R. S. Aries & Associates, 26 Court Street, Brooklyn 2, N.Y., referring to PETROLEUM REFINER item 390.

Induction Motors (Item 391)

Electric Machinery Manufacturing Company discusses in its booklet the basic theory, operation, characteristics, applications and control of large induction motors. Squirrel-cage and wound rotor motors are also explained. Photographs, cut-away views and graphs illustrate the text.

For a copy write Electric Machinery Manufacturing Company, Minneapolis 13, referring by number to this PETROLEUM REFINER item 391.

Rotating Shelves (Item 392)



Claiming to save at least 50 percent of floor space resulting in shorter trips by tool crib personnel, rotabins, offered in Catalog 106-A by The Frick-Gallagher Manufacturing Company, are circular, rotating-shelf units on ball-thrust bearings. Items in the rotabin are located so that a front position is available when needed.

For a copy write The Frick-Gallagher Manufacturing Company, 400 Shubert Building, Philadelphia 2, referring by number to this PETROLEUM REFINER item 392.

Spring Steel Clamp (Item 393)

Catalog No. 500 of Unistrut Products Company explains the application of a spring steel clamp designed for use with a slotted steel channel to accommodate tubing sizes from 3/16 to 1-inch o.d. The clamp's respacing, relocation, or removal, "all can be done in a matter of seconds," as well as allowing expansion and contraction. "Rack can be mounted or hung in any position, and where two pieces of channel are spot-welded back to back, tubing can be racked on both sides." Also described are applications and combinations of uses of concrete inserts, standard bolts, screws, nuts, washers, channels, framing, beam clamps, pipe clamps and hangers, porcelain and maple cable clamps, brackets, framing fittings, and fluorescent fixture hanger fittings. Advantages are claimed as no welding or drilling being required and 100 percent re-usable and adjustable.

For a copy write Unistrut Products Company, 1015 West Washington Boulevard, Chicago 7, referring by number to this PETROLEUM REFINER item 393.

Expansion Joint Design (Item 394)

A design guide to expansion joint selection and application is contained in the bulletin of Chicago Metal Hose Corporation. Illustrations, charts and tables are presented to help the selection and application of expansion joints in piping systems. Aids in the proper selection of size and type expansion joint are also included.

For a copy write Chicago Metal Hose Corporation, Maywood, Ill., referring by number to this PETROLEUM REFINER item 394.

now ready

new ideal..

Bulletin No. 68

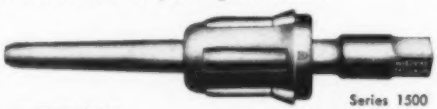
Developed in condensed, easy-to-read form, with Specification tables for selecting the *Correct Tube Expander* to meet your particular need.

Series 900

Ideal Rolling and Flaring Tube Expanders

The new 900 series for Superheater and Small Tubes.

Also improved 1500 series and Operating Accessories.



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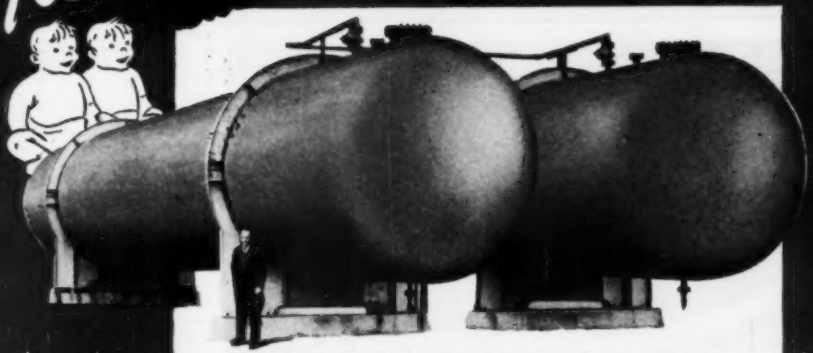
Twins



The TWIN TANKS shown are two more examples of the twin *advantages* Posey offers users of gas storage equipment: (1) sound Posey construction (2) sensible Posey estimates.

Posey shop practice eliminates many "rule-of-thumb" methods . . . many outworn fetishes . . . that do nothing to improve tank quality, but do a great deal to increase tank costs. Yet Posey omits *NO* practice that makes for dependable, pressure-resistant installations. Posey tanks are expertly designed with liberal allowances for safety factors. Physical and chemical analyses of steels used are gladly furnished to customers upon request. Strict X-ray inspection assures faultless welding. Tanks are "custom-built" to specifications in all sizes up to 30,000 water gallons.

Posey tanks are fabricated in strict accordance with standard codes . . . minimize hazards . . . meet insurance requirements . . . reduce maintenance. Posey is equipped to do the *complete* job . . . from initial design to fabrication to final erection. Write today for full details. No obligation.

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LANCASTER, PENNA., U.S.A.

DIVISIONS: Steel Plate • Asphalt • Steel Form • Brick Machinery

About EQUIPMENT and SERVICE Suppliers

Fritz Glitsch Opens New Plant

The new plant of Fritz W. Glitsch & Sons, Inc., in Dallas is arranged so that the production is routed in assembly-line precision. Complete fabricating facilities for the integrated manufacture of carbon steel and alloy trays and caps, tower internals and pressure vessels are provided in the building. Located on an 18-acre tract, the main plant is 270 by 400 feet. The offices are 90 by 100 feet. Total floor space is 130,000 square feet.

National Radiator Company Appoints Specht Manager

Robert A. Specht has been appointed manager of a new heat transfer division which The National Radiator Company, Johnstown, Pa., has created to handle the design and sales of heat transfer products for the chemical petroleum, gas and steel industries.

Specht

A graduate of Rensselaer Polytechnic Institute, Specht has been with National Radiator for several years as an Eastern sales representative in the company's industrial division. Prior to this work he was associated with Struthers Wells Corporation, Warren, Pa., as a heat transfer specialist. He is a member of the ASME and the American Gas Association.

Diamond Alkali Elects W. E. Bittner Executive

W. E. Bittner has been elected vice president-purchases of Diamond Alkali Company. He previously was director of purchases for eight years.

Bittner joined Diamond Alkali in 1916 and has served the purchasing department as a buyer, assisting purchasing agent and purchasing agent.

When Diamond Alkali had Pittsburgh headquarters, Bittner was director, vice president and president of the Pittsburgh Purchasing Agents Association. He also served as vice president of the sixth district Purchasing Agents Association and on the executive committee of the National Association of Purchasing Agents.

Tom Rankin Appointed New Manager of Metal Goods

Metal Goods Corporation has appointed Tom Rankin manager of the accessories department. He succeeds Carl Garfinkel.

Rankin

As manager of the accessories department, a relatively new development in the company's metal activities, Rankin will coordinate and direct the sales efforts of the personnel office of the company, St. Louis, Mo.

He graduated from Washington University with a degree in business administration and formerly was a partner in the advertising firm of Eggers-Rankin. He has also been employed with John Nooter Boiler Works Company, Laclede Steel Company and American Pulverizer Company.

Allis-Chalmers Ready With New Centrifugal Pump Testing

A new centrifugal pump test floor, containing "the most efficient and accurate commercial pump test facilities ever developed," has been put into service at the West Allis works of the Allis-Chalmers Manufacturing Company.

The new facilities, officials said, "will be of great importance to the company's long-standing policy of obtaining and maintaining on file complete performance data on every pump it builds." Considerable reduction in test time as well as more accurate data are expected to prove valuable both to pump designers and pump users. Included are new applications of equipment worked out by Allis-Chalmers in conjunction with equipment manufacturers, and some devices designed and built by Allis-Chal-

Allis-Chalmers' New Centrifugal Pump Test Floor.

mers especially for this application. A speed measuring device, called "the most accurate mechanism ever built for continuously measuring and recording speed," is used in conjunction with a Baldwin electric strain-type torque meter to obtain the horsepower input into a pump.

New equipment for measuring quantity of water pumped involves the use of weigh tanks rather than wiers and permits more accurate and automatic readings. Motor speed, torque, and pump discharge and inlet pressure are all recorded continuously by a photoelectric circuit.

The reduction in the time and labor required to make tests is obtained by means of greatly simplified setup procedure, it was explained.

Remah Company Debuts As Tork-Master Company, Inc.

Remah Equipment Company, because of a new product it plans to manufacture, recently renamed its company Tork-Master Company, Inc.

MacBain

The company has recently completed tests on its MacBain valves, extending over a period of months and made in the field on butane, diesel oil, hot fuel oil, gasoline, loading racks and vacuum lines.

Kenneth C. MacBain, president of Tork-Master, is a veteran of World War I, enlisting as a private and discharged as second lieutenant. During World War II, he was superintendent of the Seattle plant of the Western Gear Works. Later, he held the position of works manager of the combined operations of the Vernon and Lynwood plants of Western Gear Works at Los Angeles.

Hooker Makes W. F. George New York Area Sales Manager

William F. George, New York district sales supervisor since 1942, has been named New York district sales manager for Hooker Electrochemical Company with headquarters at 60 East 42nd Street. His territory includes the downstate New York area, New York City and northern New Jersey.

Previously George was connected with Hooker at the Niagara Falls plant and later in New York sales office. In 1919 he left the company to organize the firm of W. F. George Chemicals, Inc. In 1928 he joined the Chemical Industries magazine.

Phenoplast Names Distributor

L. Sonneborn Sons, Inc. has been appointed exclusive national distributor for Phenoplast in the industrial and institutional maintenance fields, according to Charles P. Roman, president of Phenoplast Corporation, New York.

Republic Holds Open House

The Republic Supply Company of California recently held a three day open house in its new headquarters in Los Angeles. Tours were made through

ask for T.M. REG. PYREX U.S. PAT. OFF. brand

RED LINE gauge glasses

● *Easiest to read.*

● *Meet tough service conditions.*

There is real economy in using PYREX brand *Red Line* Gauge Glasses. Made for pressures up to 200 psi., they answer most plant service requirements. Besides the *Red Line* is magnified by the water column so that liquid level is clear and distinct. It is particularly useful in hard-to-see places.

By standardizing on *Red Line* you will get better results plus longer service life. The low coefficient of expansion of PYREX brand glass No. 7740 permits heavy construction for mechanical strength. Its high resistance to chemical reaction prevents clouding and allows easy reading in long time service.

PYREX brand *Red Line* Gauge Glasses are available in sizes ranging from ½" to 1" in diameter and from 8" to 48" in length. Stocked by leading Industrial Distributors everywhere.

The complete Corning line includes tubular and flat gauge glasses, sight glasses, oil cup and lubricator glasses.

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Sales Offices: NEW YORK, CHICAGO, SAN FRANCISCO

INDUSTRIAL SUPPLY GLASSWARE

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TAKE GUESSWORK OUT OF TUBE EXPANDING

This new precision system rolls condenser and heat exchanger tubes to maximum tightness without inducing cold worked stresses in the metal. It provides uniformly tight tube joints, reduced tube end corrosion, fewer tube failures, protection to tube sheets and longer expander life.

The control consists of an AIRETOOL G-800 or G-1200 ball bearing type expander driven by an electric motor controlled by a mechanism operated with a dial calibrated for the expansion peak of each tube size and metal type.

SIMPLE and EASY to Operate

Set the dial, insert the expander and when the motor reaches maximum torque the control automatically shuts off the power producing a perfect expanding job. Ten years' shop and field experience prove the benefits of this precision device.

The AIRETOOL FISHER Electric Tube Rolling Control eliminates over and under expansion

For information and literature write The AIRETOOL Manufacturing Co., 318 S. Center St., Springfield, Ohio.

Expander for every Type of Tubular Construction

AIRETOOL

MANUFACTURING COMPANY

SPRINGFIELD, OHIO

BRANCH OFFICES:

New York, Philadelphia, Chicago, Houston, Tulsa, Baton Rouge. Representatives in principal cities.

the office and warehouse. In the warehouse several Republic manufacturers had full size, animated displays, featuring the latest in oil well and industrial equipment and supplies.

John A. Carter Elected President of Oakite Products

Oakite Products, Inc., New York, has elected the following officers: John A. Carter, president; D. C. Ball, chairman of the board; David S. Ball, first vice president; H. Liggett Gray, vice president; James Beckett, treasurer; and David A. Hearn, secretary.

Carter

Carter has been associated with the Oakite organization for 34 years, serving in recent years as assistant to the president and since December 1947, as general manager of the company. He will direct the activities of the employes who make up the company's producing, operating and selling staff.

D. C. Ball was founder and former president of Oakite, and D. S. Ball was former vice president.

Rockwell Names C. S. Bygate Assistant Vice President

C. S. Bygate has been appointed assistant vice president of the meter and valve divisions of Rockwell Manufacturing Company with his headquarters in Pittsburgh.

Bygate

He attended Franklin and Marshall College and was employed by Stone & Webster Engineering Corporation before joining Rockwell in 1943. He started in the company's equitable meter division at Pittsburgh and later transferred to general purchasing. In this department he correlated the buying habits of Rockwell's 17 divisions and subsidiaries.

Bygate already has assumed his duties.

Hufnagel Named Koch Manager, Kilsby Appointed Coast Agent

Formerly with Hydrocarbon Research, New York City, John "Jack" Hufnagel has been appointed manager of the Kaskade tray division of the Koch Engineering Company, Kansas.

Pery Kilsby, Inc., 3311 East Slauson, Los Angeles, has also been appointed Pacific Coast representatives for Koch Kaskade fractionating trays.

James Hepburn Is Worthington Assistant Division Manager

New assistant manager of the vertical turbine pump division of Worthington Pump and Machinery Corporation, Harrison, N. J., is James W. Hepburn who headquarters at the Denver Works and is responsible for customer relations in the sale of vertical turbine pumps in the territories west of the Mississippi River

as well as Chicago, St. Paul, Minn., and New Orleans.

Hepburn joined Worthington in 1929 as a sales engineer, was made district manager of the El Paso office in 1943, and since 1945 has been in the reciprocating pump division.

Los Angeles Tube Turns, Inc. Makes Change in Address

The Los Angeles branch office of Tube Turns, Inc., Louisville Ky., manufacturers of Tube Turn welding fittings and flanges, has been moved from its former office at 1489 West Washington Boulevard to suite 447 in the General Petroleum Building, 612 South Flower Street.

Bosemer

Norton P. Bosemer is manager of the Los Angeles branch. He is a native of Louisville, and joined the sales staff of Tube Turns, Inc. in 1937. He was assigned to the San Francisco office in 1944, and transferred to Los Angeles in 1947.

Texas Casting Company Names McGee Product Engineer

John K. McGee has been named product development engineer for Texas Electric Steel Casting Company, Houston.

McGee

A graduate of Carnegie Institute of Technology, McGee served the Army Air Forces as an engineering officer and in 1943 went to Manchester, England, where he held the rank of major, helping to establish the Army Air Forces' largest aircraft replacement parts depot in England.

After his discharge, McGee was superintendent for the Applied Mechanics Company, Boston, manufacturers of equipment for home heating plants. Transferred to the Moore Drop Forging Company, Springfield, Mass., McGee served as senior tool engineer for the automobile parts and tool manufacturing company until he was employed by Texas Electric Steel Casting Company.

Lincoln Electric Plans Ohio Plant for 1950

The Lincoln Electric Company of Cleveland, Ohio, has completed arrangements with The Austin Company of Cleveland for the immediate construction of an $8,500,000 manufacturing plant to be erected in Euclid, Ohio, sometime in 1950. The present plant will be available for sale or lease at that time.

The new one-story building will contain more than 850,000 square feet of floor area on a 65-acre site on St. Clair Avenue between East 222nd Street and Babbitt Road. James F. Lincoln, president, says it is to have an increased po-

HELICOID GAGE BOURDON TUBES:

- K-MONEL
- ALLOY STEEL
- STAINLESS STEEL
- PHOSPHOR BRONZE

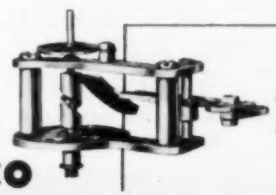
Make Sure You Select The Right One

• It pays to use the right kind of gage for the job. For example, a gage made with a K-Monel Bourdon tube won't corrode on certain services which ruin bronze or steel or even stainless steel Bourdon tubes in a short time.

Some such services are Hydrogen Sulfide (sour oil or gas), Hydrofluoric acid, Aluminum Chloride, Aluminum Fluoride, Ammonium Sulfate, Black Liquor, Carbon Tetrachloride, Ethyl Chloride, Oxygen, Potassium Sulfate, Sodium Fluoride, Sodium Hydroxide, and many others.

HELICOID developed the K-Monel Bourdon tube to give better and longer gage service—to eliminate trouble—to reduce cost. Helicoid K-Monel gages are guaranteed accurate to ½ of 1%. They stay accurate longer.

Of course, bronze or alloy steel or stainless steel Bourdon tubes are each best under certain conditions. It depends on the service. Use the right gage for the job. Write us if there's any doubt.



Only Helicoid Pressure Gages have the Helicoid Movement

ACCO

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE
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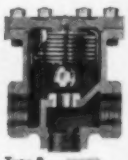
TRADE MARK

Nicholson Steam Traps

STOP BACK-UP of CONDENSATE



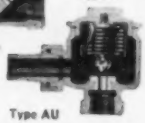
Type B

Operate on Lowest Temperature Differential

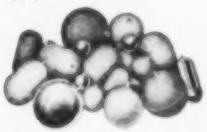
Repeated comparative tests by large trap users show that Nicholson steam traps operate on lowest temperature differential, and thus prevent waterlogging. Plant records show that, by keeping equipment full of live steam, they have increased production of cooking kettles, for example, as much as 30%. Widely specified for preventing damage to thin gauges. Eliminate "cold blow" in unit heaters. 5 types for every industrial application. Size ¼" to 2"; press. to 225 lbs. BULLETIN 1047.

Type A

Type AHV



Type AU



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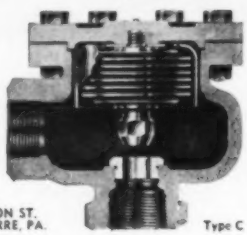
Stainless, monel, steel or plated steel. Welded. In all sizes and shapes; for operating mechanisms and as tanks or vessels. 2-day delivery. BULLETIN 348.



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W. H. NICHOLSON & CO. 207 OREGON ST. WILKES-BARRE, PA.

PLATINUM & PALLADIUM CATALYSTS

PLATINUM CRUCIBLES, DISHES AND ELECTRODES AND PLATINUM-CLAD APPARATUS

Write for our descriptive booklet on catalysts R-21

THE AMERICAN PLATINUM WORKS

Refiners and Manufacturers

PRECIOUS METALS SINCE 1875

231 NEW JERSEY R. R. AVENUE
NEWARK 5, N. J.

tential manufacturing capacity, and also the opportunity for making better products at lower costs which the plant has been designed to provide.

Cooley, Peterson Named Harshaw Branch Managers

Cooley

Peterson

The Harshaw Chemical Company, Cleveland, Ohio, has appointed Ralph C. Cooley, Jr., as branch manager of the newly established Harshaw scientific division in Houston and Thor H. Peterson as branch manager of the Houston office for sales and distributing of industrial chemicals.

Cooley was born in Houston in 1919, and attended San Jacinto Senior High School, The University of Texas and Southern Methodist University. Since 1944 he has been associated with Harshaw Chemical in Wichita, Kan., and Philadelphia.

Peterson was born of Danish parents in Chicago, 1900, and attended Valparaiso and DePaul Universities. From 1922 to 1942, he was connected in a sales capacity, with the Chicago branch office of the Harshaw Chemical Company and since 1942 he has been in charge of the industrial branch in Houston.

Rockwell Names Bush Agent

Roy R. Bush has been appointed special representative for the Nordstrom valve division of Rockwell Manufacturing Company.

Bush

Bush joined the company's sales staff in July, 1934, and has been assigned to the Tulsa district office ever since. He was previously employed by Texas Pipe Line Company in West Texas and also has had experience on drilling rigs in the Mid-continent area where he worked as a tool dresser and roughneck. Bush attended Oklahoma University. He was the past president of the Natural Gasoline Supply Men's Association and a member of the A. P. I., Tulsa Engineers Club and the Technical Club of Oklahoma.

Leeds & Northrup Celebrates Birthday in Convention Hall

In celebrating its 50th anniversary, Leeds & Northrup Company was host to 3500 employes and their guests at a dinner, entertainment, and dance in Convention Hall, Philadelphia, June 4.

C. S. Redding, president of the com-

pany, spoke on the vision and achievements of Morris Evans Leeds, founder of the company and now chairman of the board. Leeds received a gold 50-year service plaque and a bound testimonial expressing the organization's esteem for its founder presented by Robert Craig, president of the Leeds & Northrup Co-operative Association, J. H. Swope, president of the Leeds & Northrup Employes' Union, and Mr. Redding.

Clark Brothers Promotes Two in Eastern Offices

Clark Brothers Company, Inc. has promoted A. G. Van Campen from sales

Van Campen

McDonald

Latimer

engineer in the New York office to district manager of the Chicago office and R. C. McDonald from an associate company to Clark's New York office to fill the vacancy left by Van Campen.

Van Campen joined Clark's experimental engineering department in 1936 and later went into the technical service, sales engineering and enginering departments. In 1945 he became New York sales office district engineer and in 1947 was made sales engineer.

McDonald, after a Worthington student training course, was assigned in January, 1940 to the centrifugal pump application division. In 1943, he became associated with Foster-Wheeler Corporation. Since 1946 he has been with Pacific Pumps, Inc. as a sales engineer in the New York office.

T. P. Latimer recently joined Clark Brothers in the turbo-machinery sales division. He began his mechanical engineering course at Cornell University in 1942, returning after the war to receive his M.E. degree.

General Detroit Buys Plant

The General Detroit Corporation and its affiliate, The General Pacific Corporation, have purchased Fire Hose Manufacturing Company, Patterson, N. J., bringing to seven the number of factories owned by the group. Manager of the new plant is C. W. Abele, formerly New York divisional sales manager of The General Detroit Corporation. He will continue as export manager also.

Stentz to Represent Orlich

Stentz Equipment Company has been appointed district sales engineers in Kansas, Oklahoma and Texas for the

QUICK

Pipe Reaming

THAT SAVES PIPE

RIDGID

Extra-Long-Taper Reamer won't thin, flare or split pipe

● Secret of the RIDGID's safe easy reaming is its extra long taper. With a few light ratchet turns, you whisk the burr from pipe or conduit without fear of thinning, flaring or splitting. You save time, work *and* pipe. Two sizes: No. 2, ⅛" to 2"; No. 3, ⅜" to 3." No. 2 reamer unit available without ratchet handle for use in RIDGID No. 00R threader handle. Ask your Supply House.

Reamer unit fits RIDGID No. 00R Ratchet Handle.

RIDGID

WORK-SAVER PIPE TOOLS

THE RIDGE TOOL CO. • ELYRIA, OHIO

Orchem Pump Division of Orlich Brothers Machine Works, Philadelphia. Sales offices of the company are located in Dallas, Houston, Wichita, Kan. and Tulsa. S. L. Stentz is founder and president.

W. C. Osha Is Superintendent

L. O. Koven and Brother, Inc., Jersey City, N. J. has appointed W. C. Osha plant superintendent of its Dover fabricating plant. Formerly he was assistant general supervisor of welding for Pullman Standard Car Manufacturing Company. For many years he was geneal supervisor of welding for American Car and Foundry Company. Osha is a graduate of Purdue University.

Johnson, Heyck Merge as Manufacturer Representatives

Curtiss D. Johnson and T. R. Heyck have formed Johnson-Heyck Inc. located at 425 West Building, Houston 2, to act as manufacturer representative for Aurora Pump Company, Aurora, Ill.; Forney Engineering Company, Dallas; Eastern Industries, Inc., New Haven and East Norwalk, Conn.; The Dampney Company of America, Boston; Vulcan Soot Blower Corp., Dubois, Pa.; Joy Manufacturing Company, Pittsburgh; Sier-Bath Gear & Pump Co., Inc., North Bergen, N. J.; Wagener Steam Pump Company, Canton, Ohio and Saval, Inc., Los Angeles.

Johnson has been in the general machinery business in this territory for many years, first with Sullivan Machinery Company, now a part of Joy Manufacturing Company, and later in 1938, with The Tennant Company, Houston. For the past three years, he has been in business as the Curtiss Johnson Company which has now been succeeded by Johnson-Heyck Inc.

Heyck became associated with The Tennant Company in 1922 resigning in 1939 to accept a position with Griscom-Russell Company in its Houston district office. In April 1949, he resigned to form Johnson-Heyck Inc.

Mathieson Chemical Lists Six Changes in Sales Staff

Mathieson Chemical Corporation has announced changes in its sales department executive staff. D. W. Drummond has been named vice president and director of industrial chemical sales, and S. L. Nevins has been named vice president and director of agricultural chemical sales.

Drummond

Other appointments include J. O. Logan, sales manager, industrial chemicals; R. J. Quinn, assistant sales manager, industrial chemicals; L. P. Thomas, southwestern sales manager, industrial chemicals; and J. S. Whittington, sales manager, agricultural chemicals.

Thomas will be located in Houston, and Quinn and Whittington will be in Baltimore, Md. All others will be in the company's executive offices.

Frank Re Pass Development Engineer for Manning, Inc.

Manning, Maxwell and Moore, Inc., has engaged Frank M. Re Pass, Jr. as development engineer for Consolidated safety and relief valves. His headquarters will be at the Bridgeport, Conn. plant of the company.

Since his graduation from Tulane University in 1936 with the degree of mechanical and chemical engineer, Re Pass has been connected with safety valve engineering and sales. He was formerly assistant to the vice president in charge of engineering and sales of Crosby Steam Gauge and Valve Company and recently assistant sales manager of J. E. Lonergan Company.

Gro-Cord Distributor Named

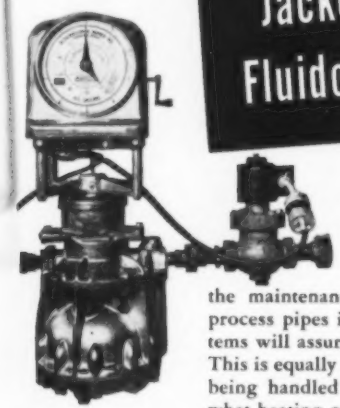
Dallas Manufacturing and Sales Company, Dallas, has been named exclusive distributor in the United States and all foreign countries for Gro-Cord pipe repair gaskets. According to C. E. Sherman, president, the gasket is used by oil and pipeline companies for making temporary repairs. It may be used over leaks in conjunction with a welded plate repair or with a chain jack. The gaskets will hold a 1600 psi. pressure.

Wheelco Opens New Office

Wheelco Instruments Company, Chicago, has opened a district office for the territory of Kentucky, southwestern

Complete

Jacketed Pipe and Fluidometer Systems



For all Liquid Handling Problems

In any processing operation where the maintenance of a uniform temperature in the process pipes is necessary, H & B jacketed pipe systems will assure dependable, economical production. This is equally true regardless of whether the material being handled requires a hot or cold temperature, what heating or cooling medium is used, or whether the material is corrosive or non-corrosive. Write for Bulletin S-47.

The Fluidometer—If you have a liquid batching problem—involving either light or heavy liquids—investigate the Fluidometer System. The H & B Fluidometer is an accurate, dependable, completely automatic metering system adaptable to practically every liquid measuring problem in industry, whether it involves gallons, barrels or tank cars. Write for new Bulletin FL-49.

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STAINLESS STEEL
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in your product in place of common steel

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- 2 Resistance to High Temperatures
- 3 Non-Magnetic
- 4 Non-Sparking
- 5 Re-Usable
- 6 Attractive Appearance
- 7 Easy to Clean
- 8 High Strength
- 9 Long Life
- 10 Lower Ultimate Cost
- 11 Resistance to Fatigue
- 12 Easy to Plate or Finish
- 13 Resistance to Abrasion and Wear

THE H. M. HARPER COMPANY
General Offices and Plant
Morton Grove, Illinois (Suburb of Chicago)
New York Office and Warehouse
200 Hudson Street, New York 13

Branch Offices: Atlanta, Cambridge, Cincinnati, Cleveland, Dallas, Denver, Detroit, Grand Rapids, Los Angeles, Milwaukee, Philadelphia, Pittsburgh, St. Louis, San Francisco, Seattle, Toronto (Canada).

HARPER
EVERLASTING FASTENINGS

Ohio and northeastern Indiana. E. C. McFaul is manager. His office is located at 307 East Fourth Street, Cincinnati 2.

J. L. Highsmith & Company has been assigned the state of North Carolina. Offices are at 111 Corcoran Street, Durham.

Globe Steel Tubes Company Makes Four Changes in Sales

Scott

Krell

Globe Steel Tubes Company has made changes in its sales staff as follows: K. F. Krell, promoted to the position of manager of sales, welding fittings; John F. Scott to the position of manager of sales, stainless and alloy tubing; John Koss, appointed to the position of sales representative, Chicago district; and J. J. Lukens to the position of sales representative, New York district.

Krell joined the general sales staff of Globe in 1942. He was appointed advertising manager in 1944 and sales service supervisor in 1946. In 1947, he was appointed Chicago district sales representative which position he held until his recent promotion.

Scott came to Globe in 1940, first serving as a metallurgist. Since 1947, he has been sales representative for New York district.

Koss joined the general sales staff of Globe in 1946 and has been in charge of export sales.

Lukens started in Globe's laboratories in 1938 and was transferred to the general sales department in 1948.

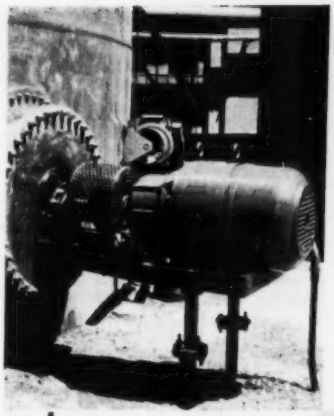
Air Reduction Appoints R. N. Chapin Purchase Agent

Air Reduction Sales Company, New York, manufacturer of industrial gases and welding equipment, has announced the appointment of Richard N. Chapin as general purchasing agent.

Chapin, a graduate of Rensselaer Polytechnic Institute, joined Air Reduction in 1935. From 1942 to 1945, he served as a buyer and since then, until his recent appointment, he was assistant purchasing agent. He succeeds Walter R. Clark, who resigned from Air Reduction to join U. S. Industrial Chemicals, Inc., as head of their purchasing department.

Worthington Promotes Four, Moves Division to Dunellen

Worthington Pump and Machinery Corporation has announced staff changes as follows: Hobart C. Ramsey from executive vice president to president; Edwin J. Schwanhausser from vice president in charge of sales to executive vice president; Clarence E. Searle from president to vice chairman of the board of directors, and John J. Summersby from assistant vice president and gen-



SIDE ENTERING MIXER FOR OILMEN

Eastern side entering agitators are specially engineered for large tank installations. Material tending to settle during mixing is kept in motion by the propeller; bottom precipitation is thus prevented. Cast ribbed bases supporting motor and stuffing box insure rigid alignment — eliminate wear and leakage.

These heavy duty mixers are available with pressure stuffing box, twin rotary seal or mechanical rotary seal; also with outboard stuffing box which can be repacked without emptying tank. They're powered with motors rated from ¼ to 30 H.P., with rotating speeds from 400 to 1725 R.P.M.

WRITE FOR FULL DETAILS

Eastern
INDUSTRIES, INC.
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PENNSALT

Anhydrous Ferric Chloride

Catalyst in oil refining and organic reactions

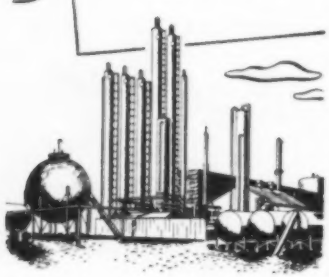
Anhydrous Ferric Chloride is a water-free form containing 95.5%—98% $FeCl_3$ by weight. It is manufactured in this country exclusively by Pennsalt. Pennsalt Anhydrous Ferric Chloride possesses unique solubility in a wide range of organic solvents. This property makes it valuable as a catalyst in *condensation, polymerization* and *chlorination* reactions.

Properties:
Appearance—*fine, greenish-black crystals.*
Melting point—*Approx. 580° F.*
Boiling point—*Approx. 600° F.*
Bulk Density—*Approx. 85 pounds per cu. ft. as packaged.*
Solubility in water—*74.4 grams per 100 ml. at 32° F. 535.7 grams per 100 ml. at 212° F.*
Soluble in: *alcohol, acetone, ethers, pyridine, ethyl acetate, nitroethane, ethyl bromide and others.*

Other uses of Pennsalt Anhydrous Ferric Chloride: manufacture of iron salts, paint pigments, ceramics; condensing reagent in making intermediates; conditioning sewage sludge. For further information write:

Heavy Chemicals Division
Pennsylvania Salt Mfg. Company
Philadelphia 7, Pa.

PENN SALT
chemicals



eral sales manager to vice president in charge of sales.

Ramsey, who graduated from the United States Naval Academy at Annapolis in 1915, joined Worthington in 1920 after serving in World War I as a lieutenant commander. He has served Worthington as sales engineer, manager of the export department, assistant general sales manager, vice president in charge of international business, and vice president in charge of engineering and manufacturing operations, including seven years in Europe with Worthington foreign operations. He has been executive vice president since 1945.

Schwanhausser began with Worthington as an engineer, and has served as assistant manager at Harrison, manager of Buffalo Works, and in 1939 as vice president. Since 1945 he was vice president in charge of sales.

Summersby joined Worthington in 1916 and has been connected with the sales department since 1917. In 1937 he was appointed assistant vice president and general sales manager.

Worthington also announces the expansion of the water treating equipment sales division and the transfer of that division to the corporation's Dunellen Works at Dunellen, N. J. The transfer is being made from the Harrison Works. ore/-isftel.rj mfwy mmfw mfwypaoia

Selas to Produce Davison Silica Gel Dehydrators

Effective July 1, 1949, the Selas Corporation of America, Philadelphia will take over the industrial dehumidification equipment activities of the equipment section, engineering division, The Davison Chemical Corporation, Baltimore. R. S. Van Note, formerly manager of the equipment section, has joined Selas as manager of the dehydrator division.

Selas, will be able to augment its activities by this move and will be able also to conduct related research. Design, production, sales and service will be offered by Selas.

Smith Buys Anco as Anchor Carries Out Stock Purchase

W. A. Baden and Paul R. Smith, president and vice-president, respectively, of Anchor Petroleum Company, Tulsa, have announced acquisition by Anchor Petroleum Company of Smith's stock interest in that company. They also announced that Smith and associates have acquired from Anchor Petroleum 100 percent of the capital stock of Anco Manufacturing and Supply Co.

Anchor is a supplier of liquefied petroleum gasses and other petroleum products, and Anco Manufacturing and Supply Company is a supplier of equipment and appliances used in the liquefied petroleum gas industry.

Brown Joins Quaker Oats

Lloyd H. Brown, formerly associated with A. J. Norton, chemical consultant, Seattle, has joined the chemicals department of The Quaker Oats Company, Chicago, to do studies on furfural and derivatives.

Jefferson Changes Offices

As a result of expansion in its activities, Jefferson Chemical Company, Inc. has moved its executive and sales offices to new and larger quarters at 711 Fifth Avenue, New York 22.

JERGUSON
Explosion-Proof
GAGE ILLUMINATORS

Give Even, No-Glare Low Cost Lighting Greater Safety Of Operation Faster, Easier Gage Reading

JERGUSON Explosion-Proof Gage Illuminators give you the best, lowest cost, most efficient gage lighting.

Utilizing the principle of solid wedge lighting, Jerguson Illuminators give clear, *even* lighting, without bright spots. Light flows through the plastic wedge and is reflected evenly through the back of the gage glass to give quick, easy, accurate reading. You get better illumination at lower cost because only one small lamp is required. Savings in electricity soon pay for the illuminator.

Jerguson Illuminators have aluminum explosion-proof housing for the wiring and heat resisting glass explosion-proof housing for the lamp. You get maximum safety, more efficient lighting with Jerguson. Made for all sizes of transparent gages. It will pay you to investigate

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National Tank's New Plant at Tulsa

Supplementing its line of oil industry production equipment, National Tank Company has opened a new plant in Tulsa, which will manufacture fractionating and refinery columns; bubble, absorber, distillation and stabilizer towers; chemical tanks; debutanizers; depropanizers and vacuum stills. Built on a 36½ acre site, the plant covers five acres. Special equipment installed includes two 50-ton cranes, seven 5-ton cranes, six 10-ton cranes and a 400-ton hydraulic press. The new annealing furnaces are 15 by 15 by 80 feet. There is also a 2½-inch capacity plate bending rolls and equipment to X-ray steel up to 20 inches thick. Translucent Fiberglas and plastic sheets are used for the skylights and windows.

Establishes New York Office

National Technical Laboratories, manufacturers of Beckman Instruments, recently established a New York service department located at 1114 First Avenue, New York.

E. D. Haller and E. C. Bowen are the company representatives in the New York area and jointly supervise sales activities in the Eastern district.

Other service departments are located in Chicago and Los Angeles.

Gordon Catts New Division Sales Engineer for Eggelhof

New division sales engineer for Eggelhof Engineers is Gordon R. Catts, Jr., Corpus Christi, Texas and his territory covers South Texas.

Catts

A graduate in mechanical engineering from the Georgia School of Technology, Catts was employed by Westinghouse Electric Corporation for five years. Serving 5½ years in the Army, he was aide to the commanding general, 4th Service Command and with the Engineering Corps in the Philippine Islands as a lieutenant colonel.

General offices of the company are in Dallas and Houston. Division offices are in San Antonio and Lubbock, Texas and New Orleans and Shreveport, La.

Houston Sales Office Opened

M. H. Detrick Company has opened a sales and service office at 4101 San Jacinto, Houston 4. Alliger & Sears, 5646 Navigation Boulevard, Houston, which heretofore handled the Detrick account, will discontinue that connection.

Patterson Appoints Executive

The Patterson Foundry & Machine Company, East Liverpool, Ohio, has appointed Everett S. Bissell vice president in charge of sales, research labora-

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COPPER SULPHATE

is preferred by leading refineries because of its high copper content, dependable uniformity and exceptional purity and freedom from foreign and inert matter.

99% + PURE

Quotations on request, on any quantity required. Shipments can be made from our nearest plant.

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QUICK TURBINE REPAIRS

If you need dependable Turbine repairs *in a hurry*, call us. We are completely equipped to repair and dynamically balance turbine rotors and any High Speed rotating elements in our modern shops.

25 Years of Successful Experience

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We Have Just Received the Following

New VALVES

Which Are Ready for Immediate Delivery, at Sensible Prices:

Flanged End Gate Valves, Crane 33X

25	3" 300#	Cast Steel, OS&Y
182	4" 300#	Cast Steel, OS&Y
112	6" 300#	Cast Steel, OS&Y
25	8" 300#	Cast Steel, OS&Y
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We also invite your inquiries for any items not listed hereon; we have a very complete line of all types of valves and fittings.

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PIPING SUPERINTENDENT

Construction firm has opening in California for an experienced Piping Supt. Minimum 5 years experience on lump sum contracts. Furnish experience record and photo. Address: Box 150-R, c/o Petroleum Refiner, Houston, Texas.

Established reliable industrial plant Engineering and Construction firm in Houston, Texas, wishes to license the engineering and/or construction processes in the Chemical, Petro Chemical or Petroleum industry in the Gulf Coast and Southwest Industrial areas. Address: Box 149-R, c/o Petroleum Refiner, Houston, Texas.

CHEMICAL ENGINEER, single, 21, M.S.E. University of Michigan 1949, seeks research and development position in petroleum refining or petrochemical field. Undergraduate work M.I.T., N.Y.U. Graduate work in Catalytic Reactor Design, Thermodynamics, Distillation, Heat Transfer, Colloid Chemistry, honor student. 1¼ years varied industrial experience, good references. Address: Box 151-R, c/o Petroleum Refiner, Houston, Texas.

ERNST Liquid Level Gages

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One (1) New 5'-6" I.D. x 61'-0" overall height Babble Tower made of 1¼" thick, 11-13% Chrome Stainless Steel, Type #405. Stainless Steel Support Plates in place for fifteen (15) trays, (trays not included.) Constructed in accordance with the API-ASME Code, Stress relieved and Radiographed. Designed for 400 PSI @ 750° F. Fabricated by A. O. Smith Corporation. Platform and Ladder Clips installed.

WOOD RIVER OIL & REFINING COMPANY, INC.
335 West Lewis Street,
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NEW FRACTIONATING TOWER REFLUX DRUM

One (1) New fractionating tower, 5'-0" I.D. X 89'-6" over-all height X 1⅛" plate. Thirty-four (34) bubble trays, ten (10) 18"-300# manways. Stress relieved and built in accordance with API-ASME Code for 350 PSI working pressure.

One (1) new horizontal reflux drum, 5'-6" I.D. X 18'-6" over-all length X 1-3/16" plate. Stress relieved and built in accordance with API-ASME Code for 350 PSI working pressure.

ROCK ISLAND OIL & REFINING CO., INC.
335 West Lewis St. Wichita, Kansas
Phone 7-3325

tories, chemical engineering and process engineering. Bissell was formerly vice president and general manager of Mixing Equipment Company. His headquarters will be at East Liverpool.

Landers Named Marcus Agent

L. Morris Landers Company, Atlanta, Ga., has been appointed territorial representative of Marcus Transformer Company, Hillside, N. J., in the states of Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina and Tennessee.

PAINTS OVER RUST!
RUSTREM STOPS RUST!
No priming, scraping, brushing

Rustrem paints right over rust. For stacks, fire escapes, bridges, fences, flashings...all metal. Farm, auto, marine, machinery. Black and aluminum.

SPECO, Inc. 7308 Associate Ave. Cleveland 9, Ohio

Laurence C. Johnston Becomes Brown District Sales Manager

Brown Fintube Company, Elyria, Ohio, has appointed Laurence C. Johnston district sales manager with headquarters in New York City.

Johnston has been engaged in the heat transfer field for the past 15 years. Prior to his new association, he was eastern district manager of Process Engineering, Inc. and chief engineer of Patterson-Kelly Company, Inc.

Johnston

American Flange Opens Plant

American Flange and Manufacturing Company, Inc., has opened a new plant in Linden, N. J. with complete facilities for the production and delivery of Tri-Sure closures. John Myers, secretary of the company, presided at the ceremonies. Other factories are located in St. Catharines, Canada, and Chicago.

Air Reduction Company Opens Michigan Oxygen Plant

Air Reduction Company has opened in Flint Mich., a new $250,000 oxygen plant which will produce more than 4 million cubic feet of oxygen per month.

This plant also will be an acetylene gas supply point and a store room for welding equipment and supplies. Leo Vansaw has been appointed plant superintendent.

Agnew Is Laclede Executive In Charge of All Plant Operations

Albert B. Agnew became vice president in charge of operations of all plants of Laclede-Christy Company and subsidiary companies, effective June 1. He was formerly vice president and general manager of the company in Pennsylvania for two years and was also associated with Harbison-Walker Refractories Company for more than 30 years.

Dowell Moves Ray Osterhout to Company Office at Odessa, Texas

Ray S. Osterhout, former service engineer with Dowell Incorporated, El Reno, Okla., has been named sales engineer in Odessa, Texas. A graduate of the University of Tulsa and a veteran of World War II, he has been with Dowell since 1943.

Duffy Named Representative

Ben King Duffy has been appointed representative by General American Transportation Corporation to handle plate, welding and process equipment division sales in the Pittsburgh district. He was formerly sales engineer for the Turbo-Mixer unit of the company.

General American Elects

Harold D. Skyrm has been elected a vice president of General American Transportation Corporation, Chicago. He recently was also made head of the process equipment, plate and welding and Wiggins vapor seals divisions. His offices are in Chicago.

Lectro Sales Agents Assigned

Two new sales agents have been named to represent Pittsburgh Lectrodryer Corporation. They are The Kerr Machinery Company, Kerr Building, Detroit 26; and G. Baillie Houliston, 707 Race Street, Cincinnati 2. They will act as exclusive agents in the Detroit and southern Ohio areas respectively.

Marley Modernizes Plant

The Marley Company, Inc. has completed the modernization program of its plant at Louisville, Ky. C. W. Zimmerman is plant manager. The plant will primarily fabricate metal for company products, but will also assemble some of the smaller units.

Builders Group Make Changes

Builders Iron Foundry, Providence, R. I., has promoted Earl H. Bradley to executive vice president and Irving O. Miner to vice president. Bradley was formerly vice president and Miner was chief engineer.

CLEAN Heat Exchangers This way and Save Money

PROPER maintenance of heat exchange units brings production costs down. So when excessive deposits of wax, gum, carbon, lime scale "bug-up" your equipment, get rid of them. Not by disassembling units—that method is too slow, too costly—but by fast "on-line" Oakite method of circulating hot solution of recommended Oakite cleaning compound.

Detailed Oakite procedure for cleaning-without-dismantling heat exchangers yours in free Digest of Maintenance Cleaning for the Petroleum Industry. ASK for the "88" Digest. Oakite Products, Inc., 50B Thames Street, New York 6, N. Y.

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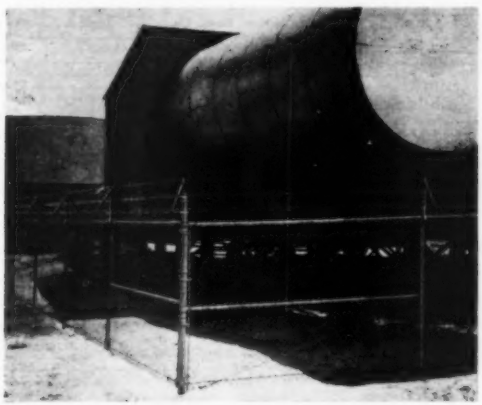

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Specify *Realock* for a tailor-made installation.

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The Colorado Fuel and Iron Corporation

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Pacific Coast Sales: The California Wire Cloth Corporation, Oakland, Calif.

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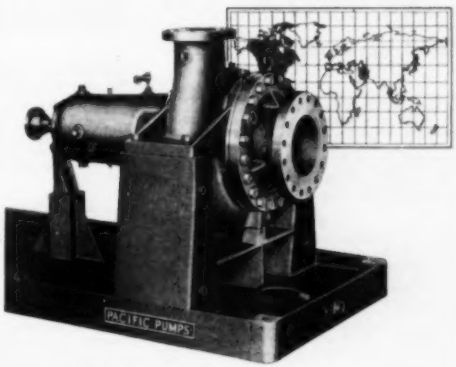
IN THE U. S. A. – CANADA – IRAN

are performing the toughest job for 42 "cats"



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Record-Breaking Runs

NEVER A FORCED SHUT DOWN
Because of Pump Failure.

Capacities to 3000 G.P.M.
Heads to 450 Ft.
Temperatures to 800° F.

Bulletin No. 86-A on Request

PACIFIC *Precision Built* **PUMPS**

25th ANNIVERSARY

Pacific Pumps inc.

ONE OF THE DRESSER INDUSTRIES

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Offices in All Principal Cities

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in this, the July, 1949, issue of

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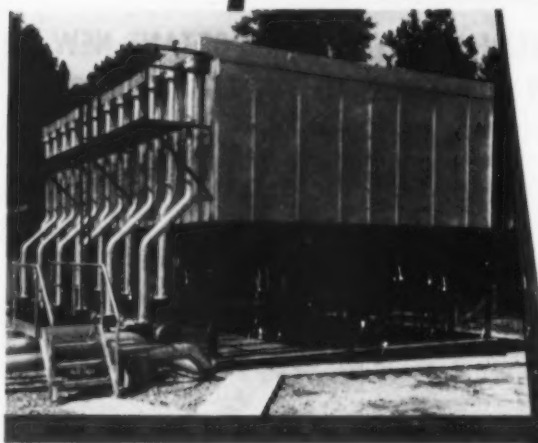

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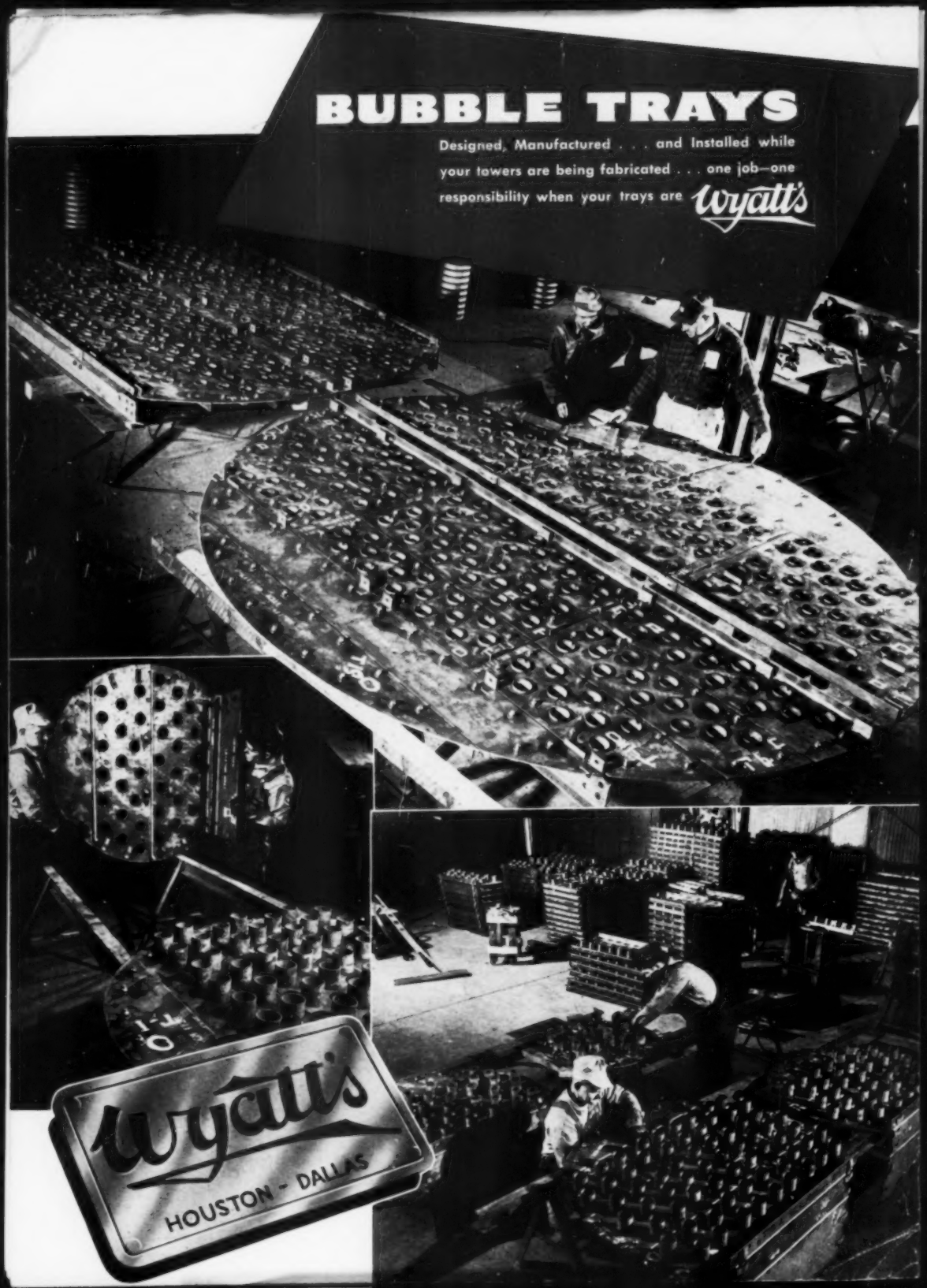
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